COMPARISON OF PREOPERATIVE TEMPORAL BONE HRCT FINDINGS WITH INTRAOPERATIVE FINDINGS IN PATIENTS WITH CHOLESTEATOMA

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The Tamil Nadu Dr. M.G.R. Medical University

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In partial fulfillment of the requirements for the award of

M.S.BRANCH IV

(OTORHINOLARYNGOLOGY)

MAY 2019

CERTIFICATE I

This is to certify that the dissertation entitled "COMPARISON OF PREOPERATIVE TEMPORAL BONE HRCT FINDINGS WITH INTRAOPERATIVE FINDINGS IN PATIENTS WITH CHOLESTEATOMA" is a bonafide record of work done by Dr.LHAM DORJEE in the Department of Otorhinolaryngology, Madurai medical college and Govt. Rajaji hospital, Madurai in partial fulfilment of the requirements for the award of the degree of M.S. Branch IV (Otorhinolaryngology), under my guidance and supervision during the academic period 2016-19.

I have great pleasure in forwarding the dissertation to The Tamil Nadu Dr. M.G.R. medical university.

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CERTIFICATE - II

This is to certify that this dissertation work titled "**Comparison of Preoperative Temporal Bone HRCT findings with Intraoperative Findings in Patients with Cholesteatoma**" of the candidate **Dr. LHAM DORJEE** with registration Number 221614103 for the award of degree of **M.S.** Branch IV in the branch of **Otorhinolaryngology**.

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I, Dr. LHAM DORJEE, solemnly declare that the dissertation entitled "**Comparison of Preoperative Temporal Bone HRCT findings with Intraoperative Findings in Patients with Cholesteatoma**" is a bonafide record of work done by me during the period of October 2017 – September 2018 at Madurai medical college and Govt. Rajaji hospital, Madurai.

This dissertation is submitted to the Tamil Nadu Dr.M.G.R. Medical University for the examinations to be held in May 2019 in partial fulfilments of the requirements for the award of M.S.Branch IV (Otorhinolaryngology).I have not submitted this dissertation work previously for the award of any degree or diploma from any other University.

Date:

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LHAM DORJEE

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INTRODUCTION

Chronic otitis media attico-antral disease(cholesteatoma) remains a significant health problem in terms of prevalence, economics and sequelae. A variety of standard surgical approaches is currently used for treating it, which are categorized as canal wall up or down approaches. Historically, surgery for Chronic otitis media has been undertaken with only plain x-rays. Recently, high resolution computed tomography (HRCT) scanning has evolved as the standard imaging technique for temporal bone, but its exact role in the preoperative assessment of patients with Chronic otitis media attico-antral disease still remains controversial. Many experienced otology surgeons seldom use computed tomography scanning arguing that nature and extent of pathology become evident during surgical dissection. Some otologists use it regularly aiming to evaluate the extension of disease, schedule the surgical technique to be adopted and identify potential risk of complications. Others reserve its utilization for cases in which there is suspicion of complication, recurrence or diagnostic doubt. CT scan findings of acquired cholesteatoma of temporal bone consists of a homogeneous soft tissue mass with local bone erosion, middle ear opacification, erosion of scutum, erosion of ossicles,

labyrinthine fistula, erosion of fallopian(facial) canal, erosion of tegmen, sigmoid sinus erosion,widening of aditus ad antrum, and automastoidectomy. Prior knowledge about temporal bone anatomy and the extent of disease may help surgeons plan and choose the appropriate type of surgery and avoid complications.

This study was done to evaluate the role of high resolution computed tomography temporal bone as a diagnostic modality in Cholesteatoma and its usefulness in determining the management strategy like the approach and route and surgical intervention required.

REVIEW OF LITERATURE

Muller in 1838 first used the term ‘cholesteatoma’ describing what he thought was a neoplastic lesion with keratin flakes appearing to look like cholesterol crystals. Despite its‘oma’ suffix, cholesteatoma is not a true neoplasm, even taking account of the propensity for the keratin epithelium to accumulate and invade the middle ear and mastoid and to erode the temporal bone. A recent consensus definition is:‘Cholesteatoma is formed by deposition of keratinizing squamous epithelium in the middle ear cleft.

Cholesteatomas are epidermal inclusion cysts of the middle ear or mastoid. (In the case of a retraction pocket cholesteatoma, the “cyst” opens into the external auditory canal). Cholesteatomas contain the desquamated debris, keratin mostly, from their keratinizing squamous epithelial lining.

Congenital cholesteatoma is cholesteatoma that occurs in a child, behind an intact tympanic membrane. Congenital cholesteatoma is thought to arise from an epithelial rest that gets trapped in the middle ear cleft in utero, and that enlarges over time to form a ball of keratinizing squamous epithelium. This entity is true, then, an epidermoid tumor, rather than the end-product of an inflammatory process, although Tos has argued the

contrary. Congenital cholesteatomas are usually discovered in infants or young children on the routine physical exam. They appear as a white mass behind an intact tympanic membrane. The average age at presentation is 4 years. The clinical behavior of cholesteatoma can vary over time. Cholesteatoma may grow slowly without causing any symptoms other than blocking sensation of ear.

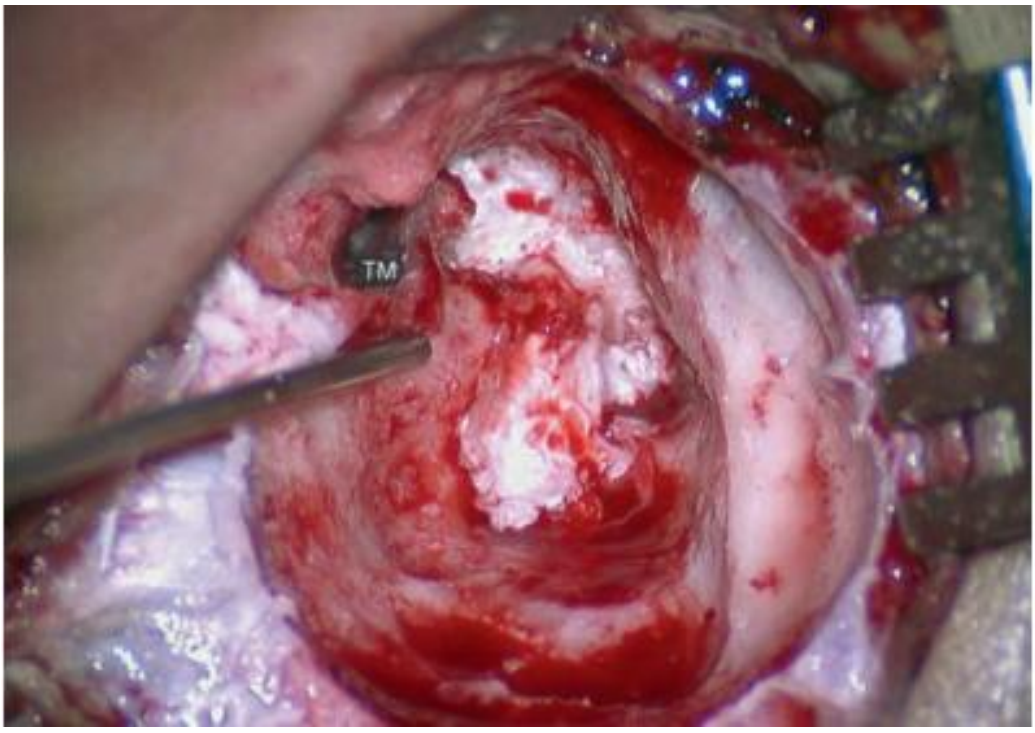


Figure 1 Cholesteatoma mass is seen eroding bone

Cholesteatoma leads to malodorous discharge when it becomes infected. The discharge may improve with topical antibiotics but is usually only temporary. Recurrent or persistent ear discharge is a feature of cholesteatoma, even when the lesion is not clinically not visible on examination. Knowing about pathophysiology and pathogenesis of cholesteatoma is particularly important, because the destructive nature of this entity is responsible for much of the morbidity associated with chronic otitis media.

Lateral epitympanic wall (scutum) is the first to be eroded in cholesteatoma. followed by ossiclular erosion (the lenticular process of the incus and the superstructure of the stapes).

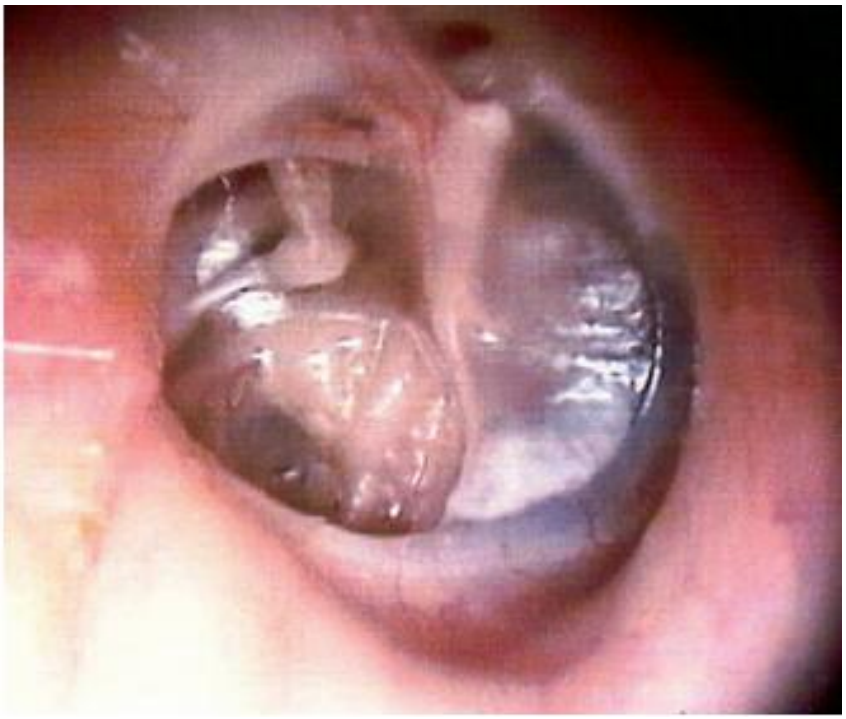


Figure 2. Retraction of Pars Tensa and Pars Flaccida

Figure 3. Infected retracted tympanic membrane

Figure 4. Congenital Cholesteatoma

In present days conventional radiography is limited in its use for evaluation of mastoid pneumatization. The high resolution computed tomography (HRCT) of temporal bone provides minute bony details and an excellent demonstration of the location of the soft tissue density but cannot differentiate the type of substance producing the abnormal density. Magnetic resonance is superior to CT in the identification of soft tissue pathology in the temporal bone. However bony structures like ossicles, scutum labyrinthine capsules are better delineated on CT temporal bones. Hence CT temporal

bone has been considered the imaging modality of choice for assessment of the ear pathology.[1]

During the earlier days, X-Rays were used, but with its limitations as an imaging modality for the investigation of diseases of the ear. Nowadays, improved spatial resolution has meant that high resolution computed tomography (HRCT) using thin sections gives excellent bone detail in petrous temporal bone. Proton magnetic resonance imaging (MRI) produces sectional images similar to CT, and the reconstruction methods are also identical. But CT is superior in imaging the temporal bone due to its ability to demonstrate both soft tissue abnormalities and fine bone details.[2]

HRCT temporal bone is now considered the most useful radiological imaging modality in demonstration of bony detail in petrous temporal bone and soft tissues density in the middle ear and the extension of the pathology into the cranial cavity. CT scanning is extremely helpful in the detection of intracranial complications.[3]

With the introduction of high resolution computed tomography, CT has become a very useful imaging technique for the temporal bone.[4]

Jackler RKet al (1984) conducted a study in forty-two patients with chronic otitis media who underwent preoperative CT scanning followed by surgical exploration of the middle ear and mastoid. The CT finding of abnormal soft tissue density with bony erosion showed high correlation with the surgical finding of cholesteatoma. On the contrary, total absence of abnormal soft tissue density on CT essentially excluded cholesteatoma. They concluded that Ct scan does have a role in the evaluation of selected patients with chronic otitis media, but needed to be interpreted keeping in mind its associated limitations and pitfalls.[5]

Mafee MF et al (1986) conducted a study of the microdissection of 250 fresh temporal bone and review of over 1000 high resolution computed tomography scans of the temporal bone. The anatomy was described, and the role of the tympanic diaphragm and isthmus in the determination of the degree of progression of middle ear pathology stressed. The appearance of pathological lesions as seen on CT temporal bones like otomastoiditis, tympanosclerosis, cholesterol granuloma, attic retraction pocket, and acquired cholesteatoma was illustrated.[6]

Yamasoba T et al (1991) used axial scans of HRCT bones to examine the structures of the anterior epitympanic recess and the surrounding tissues. The length and width of the recess and the cog was also imaged. The bony structure of the recess was found to be seldom influenced by inflammatory processes. Chronic otitis media was found to be associated with suppression of pneumatization of the temporal bone. The cells around the recess were also found to be less pneumatised than the mastoid cells.[7]

Leighton SE et al (1993) conducted a prospective study on 20 patients suspected to have cholesteatoma in order to establish the indications for CT imaging in these patients. A management plan was made in these patients following a thorough clinical evaluation. The plan so made was altered if needed, on the basis of radiological findings. Surgical findings were recorded and correlated with CT appearances evaluated. CT altered the management plan in 10 and was found to be useful in another 6 patients enrolled in the study. They concluded that CT temporal bones could be used routinely in children, medically unfit patients, only or better hearing ears, in those patients whom the tympanic membrane was not visualized properly during

clinical examination, patients who have undergone previous mastoid surgery but the operative records of the same not available, and patients with intratemporal or intracranial complications.[8]

Garber LZ et al (1994) conducted a retrospective study on 44 patients underwent surgery for cholesteatoma to compare CT with the operative findings. Results showed that though CT could detect abnormalities in the temporal bone, it could not be useful in certain special situations as in those patients presenting diagnostic dilemmas or when an associated pathology like complications, recurrent disease, etc. is suspected.[9]

The study conducted by Luchikhin LA et al on 30 patients with chronic otitis media (1995) compared temporal bone computed tomography findings with the surgical findings. The study showed that CT temporal bones provided excellent information on the pathological process wand was found to be value before subjecting the patients for surgery.[10]

Walshe P et al (2002) conducted a study on 20 patients awaiting presenting with chronic suppurative otitis media who underwent preoperative HRCT if the temporal bones and subsequently mastoid surgery was done. The HRCT temporal bone findings were compared with the intraoperative findings. They suggested that CT was useful in demonstrating the anatomy of the middle ear and mastoid, and the extent of the pathological disease in the sinus tympani and facial recess. However, it could not distinguish between cholesteatoma, mucosal disease and fluid, and it did not contribute much to the surgical management of the patients. They concluded that CT temporal bones as a routine preoperative investigation in uncomplicated mastoid surgery was of questionable value.[11]

Similar studies conducted by Sandeep Berry et al (1998) on 30 patients of unsafe chronic otitis media with preoperative CT scanning and surgical exploration of the middle ear and mastoid, and comparison of CT findings with surgical findings. The study showed that CT scan was highly sensitive for soft tissue density mass in the tympanomastoid compartment. They concluded that the CT scan of the temporal bone was best to depict pathology which is not clinically evident.[12]

Zelikovich EI (2004) used CT of temporal bone to study 87 patients with chronic otitis media. The Ct signs of chronic purulent otitis media with or without cholesteatoma were identified. CT shows changes in the walls of the middle ear cavity, including the roof and allows labyrinthine fistula and intracranial complications to be detected.[13]

Wang LE et al (2007) conducted a study to evaluate the methods of preoperative diagnosis and differentiation of pathological tissue found in the middle ear and mastoid. They concluded that CT was not reliable to diagnose and differentiate pathological tissue in middle ear and mastoid. But CT value can still be considered to provide significant information.[14]

Gerami H et al (2009) conducted a cross sectional study on 80 patients with chronic suppurative otitis media between 2000-2004 and their preoperative CT temporal bone findings were compared with the intraoperative findings during mastoidectomy. Sensitivity, specificity, positive and negative predictive value of CT scan temporal bones with regard to tympano mastoid

cholesteatoma, ossicular erosion, tegmen tympani erosion, dehiscence of facial nerve canal, lateral semicircular canal fistula were assessed followed by calculation of correlation between radiological findings and intraoperative findings. They concluded that preoperative CT scan would be helpful in planning surgical management in case of cholesteatoma and ossicular erosion. Hence CT scanning is a useful adjunct to management of CSOM.[15]

Firaz Q. Alzoubi et al (2008) conducted a retrospective study in 50 patients between January 2003 to December 2007 to compare preoperative CT scans with surgical findings. They reported that CT scan could not differentiate cholesteatoma from chronic mucosal disease. It should be used as a preoperative tool only if complications of the disease suspected.[16]

AIMS AND OBJECTIVES

1. To study the role of high resolution Computed tomography (HRCT) in patients with cholesteatoma
2. To determine the extension and site of cholesteatoma and its sac, assessing the ossicles, evaluating the facial nerve canal, the tegmen and sinus plate, and evaluating positions of dura, sigmoid sinus, and jugular bulb
3. To compare the above with intra-operative findings and proceed the surgery accordingly so as to avoid complications intraoperatively and for better outcome
4. To evaluate the results of our study and compare with similarly published studies.

MATERIALS AND METHODS

Source of Data

The present work was undertaken to study the radiological findings of CT temporal bone in patients with cholesteatoma at Government Rajaji Hospital attached to the department of ENT, Madurai Medical College, Madurai between October 2017 and September 2018.

Methods of collection of data

Sample size : A minimum of 50 patients.

55 patients with cholesteatoma presenting to ENT outpatient department at Government Rajaji Hospital attached to Madurai Medical College were taken up for study.

As soon as the patient presented to the hospital, detailed clinical history and examination were carried out as per the proforma prepared.

Laboratory investigations were done. All patients were subjected to HRCT temporal bones, 1mm axial and coronal slices.

Once the radiological findings were noted and extent of disease established, management was done accordingly

Inclusion criteria

All patients diagnosed clinically as chronic suppurative otitis media with acquired cholesteatoma and presented with chronic scanty ear discharge, which is offensive and conductive hearing loss.

Exclusion criteria

Previous ear surgery, Previous head trauma and Known history of sensorineural hearing loss, Systemic disease which may affect the ear (e.g.collagen vascular or granulomatous diseases), Malignancies of the temporal bone and skull base, and those with a history of head and neck radiotherapy.

All patients coming under the present study underwent certain investigations.

Routine investigations: Complete hemogram, bleeding time, clotting time, urine analysis, Random blood sugar, Renal function tests, Specific investigations: X-Ray Mastoids- Lateral Oblique view, HRCT of temporal bones

Duration of study: 12 months

ANATOMY OF TEMPORAL BONE

The anatomy of the temporal bone is complex and in many circumstances confusing. The temporal bones are situated at the sides and base of the skull. Each consists of the following five parts: Squamous, Mastoid, Petrous, Tympanic, and Styloid process.

SquamousPortion

The squamous portion forms the anterolateral and upper part of the bone; it is shell-like and thin. The external surface is smooth and convex, giving attachment to the temporalis muscle; it forms part of the wall of the temporal fossa. A gently arching zygomatic process arises from the lower portion of the squama and is directed anteriorly. Its lateral surface is convex and lies directly beneath the skin and subcutaneous tissue. The medial surface of the zygomatic process is concave and serves as the origin of the masseter muscle. The anterior end of the zygomatic process articulates with the zygomatic bone. The posterior portion of the zygomatic process is divided into an anterior and a posterior root. The posterior root lies above the external auditory canal and becomes continuous with the temporal line posterior to the

external auditory canal. The anterior root becomes the articular tubercle of the condylar (glenoid or mandibular) fossa. The condylar fossa is bound posteriorly to the anterior surface of the tympanic bone. The mandibular fossa is cleaved in the coronal plane by the tympanosquamous suture laterally and by that suture'sinward extension, the petrotympanic (Glaserian) fissure, medially. The portion of the condylar fossa anterior to the fissure is the articular portion of the joint; the portion posterior to the Glaserian fissure is the nonarticular portion. The internal surface of the squama is concave and irregular. Meningeal vessels groove the inner surface. The superior border articulates with the parietal bone, and the anteroinferior border articulates with the greater wing of the sphenoid.

Mastoid Portion

The mastoid portion has a rough outer surface and serves as the origin of a portion of the occipital and posterior auricular muscles. In the adult the mastoid portion is continued inferiorly into a conical projection, the mastoid process. This process gives attachment to the sternocleidomastoid, splenius capitis, and longissimus capitis muscles.On the medial side of the process is a

deep groove, the mastoid notch or digastric groove, for the attachment of the posterior belly of the digastric muscle. Medial to this is a shallow furrow, the occipital groove, that lodges the occipital artery. The inner or intracranial surface of the mastoid presents a deeper groove, the sigmoid sulcus, that lodges part of the transverse sinus.The posterior superior border is serrated and articulates with the parietal bone. The posterior border, similarly serrated articulates with the inferior border of the occipital bone. Anteriorly and above, the mastoid portion is fused with the descending process of the temporal squama; below, it enters into the formation of the external acoustic meatus and the tympanic cavity.

The mastoid process is hollowed to form a number of spaces, the mastoid cells, that vary greatly in size and number. In the upper and anterior part of the process, these cells are large and irregular, toward the middle part they diminish in size, and those in the apex of the process frequently are small. In addition to these cells a large, irregular cavity, the tympanic antrum, occurs and is situated at the upper and anterior part of the mastoid portion of the bone. The antrum communicates with the epitympanum (attic), situated

anteroinferiorly and medially by way of then arrow channel, the aditus ad antrum.

Petrous portion

The petrous pyramid is wedged in at the base of the skull between the sphenoid bone anteriorly and the occipital bone posteriorly. Its apex is directed medially, forward, and slightly upward. It contains the inner ear.

The petrous portion resembles a toppled three-sided pyramid lying on the flat surface of one of its sides. The base of this pyramid is laterally positioned and fused with the internal surfaces of the squamous and mastoid portions of the temporal bone. The apex points medially and forward (at approximately a 45° angle with the coronal and sagittal planes) and is inserted into the angular interval between the posterior border of the greater wing of the sphenoid bone and the basilar part of the occipital bone. The anterior (middle fossa) face of the petrous pyramid has a more horizontal orientation and is ‘‘longer’’ than the posterior surface, which is relatively vertical and ‘‘shorter.’’

The surface of the petrous portion often considered the superior surface actually faces somewhat anteriorly and so is more accurately called the anterior face. This anterior face forms the posterior limit of the floor of the middle cranial fossa and is continuous laterally with the inner surface of the squamous portion; it is united at these edges by the petrosquamous suture. Its surfaces are somewhat irregular and marked by depressions for convolutions of the brain and by a shallow depression medially for the reception of the semilunar ganglion (Meckel's cave) of the fifth cranial nerve. The arcuate eminence, which marks the approximate site of the underlying superior semicircular canal, is near its midportion. Anterior and slightly lateral to this eminence is a depression that marks the position of the tympanic cavity. The layer of bone that separates the tympanic and cranial cavities is usually very thin and is known as the tegmen tympani. Two small grooves cross this surface of the temporal bone, passing from the area of the foramen spinosum and foramen lacerum laterally and posteriorly to a small opening called the facial hiatus. The facial hiatus is a small opening or defect that transmits the greater superficial petrosal nerve and the petrosal branch of the middle meningeal artery. This small opening marks the location of the geniculate ganglion and first genu or turn of the facial nerve. The amount of

bone ‘‘closing’’ the facial hiatus is variable. In some cases, the facial nerve and geniculate ganglion are positioned just below the dura of the middle fossa and lack a significant bony covering.

The posterior face (surface) of the petrous pyramid forms the anterior bony limit of the posterior fossa and is continuous with the inner surface of the mastoid portion of the temporal bone at the petromastoid suture. To reiterate,this face has a more vertical orientation than the anterior surface. Near the center of this surface is the opening to the internal auditory (acoustic) canal (meatus), which transmits the seventh and eighth cranial nerves, the nervus intermedius, and the internal auditory artery. The opening of the internal auditory canal is known as the porus acoustics. The lateral end of the internal auditory canal is closed by a vertical plate of bone that separates the fundus of the canal from the vestibule. This bony separation has many perforations allowing passage of nerve filaments. These regions are called the cribriform areas. The fundus is divided by a transverse (axially oriented) crest of bone, the crista falciformis, into a smaller upper and a larger lower compartment. The crista, which arises anteriorly, continues for a variable distance along the anterior wall of the internal auditory canal.

The upper compartment occupies about 40% and the lower about 60% of the vertical dimension of the canal. In the upper compartment the facial nerve (VII) lies anteriorly, and the superior vestibular division of cranial nerve VIII lies posteriorly. The branches of the latter go to the utricle and the superior and lateral semicircular canals. A thin vertical crest of bone separates the lateral portion of this upper compartment into its anterior and posterior portions. This crest is referred to as Bill's bar. The bony bar separates the aperture for the exit of the facial nerve anteriorly from the small openings for the branches of the superior vestibular nerve posteriorly. A small channel along the posterolateral aspect of the vertical crest may be seen carrying a small branch of the vestibular nerve passing toward the ampulated end of the superior semicircular canal. In the compartment beneath the crista falciformis there are three sets of foramina. Anteriorly, a set of perforations is arranged spirally to accommodate the cochlear division of the eighth cranial nerve. Posteriorly, branches of the inferior division of the vestibular nerve take their exit, one set of foramina leading to the saccule and the remainder leading to the posterior semicircular canal. The nerve to the posterior semicircular canal follows a small channel called the singular or singulate canal.

On the posterior surface of the petrous bone, slightly posteroinferior to the internal acoustic meatus, is a small slit that leads to the vestibular aqueduct. The aqueduct transmits the endolymphatic duct and sac. The endolymphatic sac fills most of the bony aqueduct and protrudes beneath its lower margin. Thus the sac has an intraosseous part, within the aqueduct, and an extraosseous part lying between the layers of the dura of the posterior fossa. The sac is not a single cavity but rather a system of connected channels.

The inferior face (surface) of the petrous pyramid is a rough, irregular surface and forms part of the exterior of the base of the skull. It furnishes partial attachment for the levator veli palatini and the cartilaginous portion of the eustachian tube. It is pierced anteriorly by the aperture of the carotid canal. Posterior to the entrance of the carotid canal lies the jugular foramen. This aperture has an anteromedial and a posterolateral part. Cranial nerves IX, X,and XI transit the anteromedial part in close association with the inferior petrosal sinus. The sigmoid sinus curves into the posterolateral part. The cochlear aqueduct, which communicates with the basal turn of the

cochlea, arcs superiorly and laterally from the notch-like anteromedial portion of the jugular foramen.

Thus, near the midportion of the posterior surface of the petrous portion of the temporal bone, extending roughly in a straight line from cranially to caudally, are the internal auditory canal, the aperture of the cochlear aqueduct, and the jugular fossa.

There are two-minute canals that perforate the inferior surface of the petrous portion within or near the jugular fossa. The inferior tympanic canaliculus, which accommodates the tympanic branch of the ninth cranial nerve glossopharyngeal nerve (Jacobson's nerve) and the inferior tympanic artery, lies between the carotid canal and the jugular fossa. The mastoid canaliculus, which serves as entrance for the auricular branch of the vagus nerve(Arnold's nerve), is located within the lateral part of the jugular fossa.

The styloid process originates from the inferior face of the pyramid. The stylomastoid foramen is situated between the downward projections of the mastoid process and the styloid process. This foramen constitutes the terminus of the bony facial nerve canal.

The superior angle (border) of the petrous portion of the temporal bone is grooved for the superior petrosal sinus and gives attachment to the tentorium cerebelli. This superior angle, commonly referred to as the petrous ridge, represents the line of the intersection between the anterior and posterior surfaces of the pyramid. The anteromedial extremity of the ridge is notched or scalloped for the reception of the roots of the trigeminal nerve. A small notch marks the position of Dorello's canal, a small dural reflection through which the sixth cranial nerve transits into the cavernous sinus.

The posterior angle of the pyramid is defined by the junction of the lower aspect of the posterior surface with the posterior limits of the inferior surface. From the perspective of the inner surface of the skull within the posterior fossa, the posterior angle is marked by a sulcus on the petrous portion that, along with a corresponding sulcus on the occipital bone, forms the channel for the inferior petrosal sinus. An excavation on the inferior and medial aspect of the posterior surface of the pyramid, in continuity with this sulcus, is known as the jugular fossa. The corresponding depression, in continuity with the sulcus arising from the anterolateral surface of the occipital bone, is known as the jugular notch. These semilunar cavities face

one another and together form the jugular foramen. Within the temporal bone, the jugular vein has a dilated portion called the jugular bulb. The jugular bulb rises variably toward the labyrinth and middle ear.

The anterior angle of the pyramid marks the junction between the pyramid and the bones of the anterior floor of the middle cranial fossa. The anterior border is divided into two parts: the medial part, which articulates with the greater wing of the sphenoid, and the lateral portion, which adjoins the squamous part at the petrosquamous suture.

At the angle of the junction of the petrous and squamous portions along the anteromedial margin of the middle ear cavity, there are two (semi) canals placed one above the other, which are separated by a thin plate of bone. This septum is known as the septum canal is musculotubarii (cochleariform process). The upper canal contains the tensor tympani muscle, and the lower canal is the bony portion of the eustachian tube.

Tympanic Portion

The tympanic portion of the temporal bone is a curved plate lying below the squamous portion and in front of the mastoid process. Its posterior surface is somewhat C-shaped and forms the anterior wall, the floor, and the posteroinferior aspect of the bony external auditory canal. At the medial end of the canal is a narrow furrow, the tympanic sulcus, for the attachment of the tympanic membrane. The lateral border of the tympanic portion of the temporal bone is roughened, forming a large part of the margin of the opening of the external auditory canal; this is continuous with the cartilaginous part of the canal. The lateral part of the upper border is fused with the back of the postglenoid tubercle. Its medial extension forms the posterior boundary of the petrotympanic fissure.

There is considerable ambiguity in anatomic descriptions regarding the terms *petrotympanicfissure*, *tympanosquamous fissure*, and *Glaserian fissure*. Many anatomic depictions point unassailably to a junction between the squamous and tympanic portions, labeling the area the *petrotympanic fissure*. This is more easily understood if one recognizes that the tympanosquamous fissure (squamotympanic) is merely the lateral extension of the

petrotympanicfissure, and the Glaserian fissure is the medial extension of the petrotympanic fissure. This serves as a passageway for the anterior tympanic branch of the internal maxillary artery.In the most medial extreme portion of the petrotympanic fissure is the small canal for the chorda tympani, the iterchordae anterius (anterior tympanic aperture, canal of Huguier). The lower border of the tympanic bone encloses the root of the styloid process. Posteriorly the tympanic portion blends with the squamous and mastoid portions, forming the anterior boundary of the tympanomastoid fissure.

Styloid Process

The styloid process of the temporal bone averages about 2.5 cm in length and projects downward and forward from the undersurface immediately anterior to the stylomastoid foramen. It gives origin to the stylohyoid ligament and the stylohyoid, stylopharyngeus, and styloglossus muscles.

Middle Ear

The middle ear or tympanic cavity is an air-filled space located in the temporal bone between the air-filled external ear and the fluid-filled inner ear. The middle ear contains a chain of three movable auditory ossicles, the malleus, incus,and stapes. They are supported by the tympanic membrane, the anterior, superior and lateral malleal ligaments, the posterior incudal ligament, the tendons of the tensor tympani and stapedius muscles, and the annular ligament.The primary function of the middle ear is to act as an impedance element between the air-filled external ear and the fluid-filled inner ear. When sound waves hit the tympanic membrane, their energy is converted into mechanical vibrations that sets the ossicular chain in motion, transducing kinetic energy to the stapedial footplate, thus generating a wave in the cochlea. The frequency of this wave determines which hair cells are stimulated, which in turn emit a neural signal to the brain, resulting in hearing perception

Tympanic Cavity

The middle ear is a six-sided cavity containing the three auditory ossicles supported by the tympanic membrane, the auditory ligaments, the tendons of the tensor tympani and stapedius muscles, and the annular ligament. The roof formed by the tegmen tympani. The floor is also formed by a thin plate of bone, the fundus tympani, that separates the tympanic cavity from the jugular fossa. The lateral wall is mainly formed by the tympanic membrane and partly by a ring ofbone on which the membrane inserts. The ring is incomplete at its upper portion, forming the notch of Rivinus. The medial wall is formed by the lateral wall of the inner ear.The posterior boundaries are defined by the mastoid and the anterior boundaries by the carotid canal. The tympanic cavity can be divided into three subdivisions in the coronal plane: the epi-, meso-, and hypotympanum. The epitympanum is the attic, formed by an imaginary line drawn between scutum and tympanic segment of the facial nerve. The mesotympanum is the middle part delineated by the line between scutum and tympanic segment of the facial nerve on one hand, and a line connecting the tympanic annulus and the base of the cochlear promontory on the other hand. The hypotympanum is the lowest part of the

tympanic cavity and lies below the line between tympanic annulus and the base of the cochlear promontory.

Auditory Ossicles

The tympanic cavity contains three auditory ossicles: the malleus, the incus, and the stapes. The ossicles act as a lever transforming the large and weak motion of the tympanic membrane into a small and forceful movement of the stapes. The malleus is attached to the tympanic membrane and the stapes is connected to the fenestra vestibuli, traditionally referred to as the oval window. In between the incus is suspended by delicate articulations, the incudomalleal and incudostapedial joints. The malleus, named after the resemblance to a hammer, consists of a head, neck, and three processes:, the manubrium, the anterior and lateral processes. The incus resembling an anvil consists of a corpus and 2 crura (processes). The anterior part of the corpus articulates with the head of the malleus in a saddle-shaped diarthrosis. The two processes are positioned perpendicular to each other with the short process running almost horizontally backward and the long process descending nearly vertically and bending medially, ending in a little notch

covered by cartilage, the lenticular process, articulating with the head of the stapes.

The stapes similar to a stirrup, consists of a head, neck, 2 crura and a base. In between the 2 crura lies the foramen obturatorium. The 2 crura diverge from the neck and are at their end connected to an oval plate that is fixed to the fenestra vestibuli by a ring of ligamentous fibers, the annular ligament.

Suspensory Apparatus

The malleus, incus, and stapes are situated between the tympanic membrane and oval window, and are supported by the tympanic membrane, the anterior, superior, and lateral malleal ligaments, the posterior incudal ligament, the tendons of the tensor tympani and stapedius muscles, and the annular ligament.

The malleus is supported by the superior, anterior, and lateral malleal ligaments, the tensor tympani muscle tendon, the tympanic membrane, and the incudomalleal joint. The incus is supported by the posterior incudal ligament and two joints, the incudomalleal and incudostapedial joints. The

stapes is supported by the stapedius muscle tendon and the incudostapedial joint.

The AML is attached at one end to the malleal neck, just above the anterior process, and to the anterior tympanic wall by the other end. The PIL connects the incus short process to the incudal fossa. The SML runs from the roof of the epitympanic recess to the malleus head. The LML extends from the posterior part of the notch of Rivinus to the malleus neck. The tensor tympani muscle arises from the cartilaginous(upper) portion of the auditory tube in which it is contained, then swerves around the cochleariform process resulting in a tendon that attaches to the neck of the malleus.The muscle belly of the tensor tympani muscle is located anteroinferior to the tympanic segment of the facial nerve. The smallest muscle in the human body is the stapedius muscle, arising from the apex of the pyramidal eminence immediately behind the oval window, runs forward and inserts onto the posterior surface of the neck of the stapes in the majority of patients. Occasionally, it inserts on the head or on the posterior crus of the stapes due to the persistence of a greater or lesser degree of angulation between the tendon and the belly of the stapedius muscle during embryological

development. The ligaments of the middle ear solely act as a suspensory apparatus, whereas the muscles of the middle ear also exert a protective function. Contraction of the tensor tympani muscle pulls the malleus anteromedially, while contraction of the stapedius muscle pulls the stapes posteriorly. Both muscles pull in more or less opposite directions, applying forces perpendicular to the motion of the ossicular chain. Their contraction, stimulated by the acoustic reflex, is a protective mechanism that stiffens the ossicular chain, thereby protecting the inner ear of being overwhelmed by exuberant sound wave vibrations. This mechanism is also responsible for the improvement of the signal-to-noise ratio.

Inner Ear

The inner ear is a fluid-filled labyrinthine space in the temporal bone called the labyrinth, named after its complexity in shape. It consists of two parts, the bony osseous labyrinth, and the membranous labyrinth. The osseous labyrinth consists of five structures: cochlea, vestibule, three semicircular canals, and the cochlear and vestibular aqueduct. The osseous labyrinth contains perilymph in which the membranous labyrinths is bathing. The membranous

labyrinth is a collection of interconnecting sacs and ducts that follow the form of the osseous labyrinth and contain a fluid called endolymph.

The inner ear is responsible for hearing and balance. The cochlea contains distal fibers of the cochlear nerve that alter mechanical vibrations into nerve signals that are sent to the brain, resulting in hearing. The vestibule and semicircular canals are responsible for balance. The utricle and saccule,

both parts of the vestibule, determine the orientation relative to gravity by detecting linear accelerations. The semicircular canals deliver information about turning by detecting rotational movements.

The Osseous Labyrinth

The osseous labyrinth consists of three parts: cochlea, vestibule, and three semicircular canals. It is lined by a thin fibro-serous membrane covered with a layer of epithelium that secretes perilymph.

The cochlea resembles a snail-shell and forms the anterior part of the inner ear. The base of the cochlea connects with the internal auditory canal by numerous perforations through which the cochlear division of the acoustic

nerve passes. The cochlea measures about 5 mm in axial length and makes approximately two and a half turns around a central axis named the modiolus. The osseous lamina spiralis subdivides the spiral canal into the scala vestibule and scala tympani, which meet each other at the apex of the modiolus in the helicotrema. From the free border of the osseous lamina spiralis, the basilar membrane stretches to the outer wall of the bony cochlea. The basilar membrane contains hair cells that are essential for hearing.

The basal first turn of the cochlea opens in the tympanic cavity in the round window and is closed by a secondary tympanic membrane or round window membrane. When sound waves reach the stapes, an inward movement of the stapes in the oval window causes an outward bulging of the round window membrane in the round window, allowing free movement of inner ear fluids. This sets in motion a waveform that stimulates the hair cells on the basilar membrane, exciting the sensory mechanism, which results in a flow of nerve impulses to the higher centers, resulting in hearing.

The cochlear aqueduct also extends from the basal turn of the cochlea-more specific from the scala tympani—and runs parallel and posteriorly to the internal auditory canal. It opens in the inferior surface of the petrous part of

the temporal bone near the jugular fossa, lateral of the jugular foramen. It forms a communication between the subarachnoid cavity and the labyrinth and is a possible entryway for micro-organisms, although in human the lumen is small and often not patent. Its function is not clear but some authors believe that a stapes footplate gusher, leakage of perilymph through an opening in the stapes footplate, may result when the cochlear aqueduct is abnormally patent.

The vestibule forms the central part of the osseous labyrinth and is somewhat oval in shape and measures approximately 4–5 mm. It is situated medial to the tympanic cavity and leads anteriorly to the cochlea and posteriorly to the semicircular canals. In its lateral wall, the oval window is closed by the footplate of the stapes. There are two depressions in its medial wall, the inferiorly spherical recess, and the superiorly elliptical recess. They correspond with the saccule and utricle, both parts of the membranous vestibule. The recesses are perforated by several small holes forming the lamina cribrosa, which separates the vestibule from the fundus of the internal auditory canal and contains filaments of the acoustic nerve. Other openings in the vestibule are the five orifices of the semicircular canals and the vestibular

aqueduct. The latter is a bony canal between the vestibule and the posterior surface of the petrous bone and contains the endolymphatic duct, which ends posteriorly in a blind pouch between the layers of the dura mater within the cranial cavity, the endolymphatic sac. The endolymphatic duct and sac play an important role in the normal metabolic activity of the inner ear. A loss of function results in a progressive increase in volume and biochemical degradation of endolymph. The vestibular aqueduct is enlarged when it measures more than1.5 mm in diameter halfway between the vestibule on one hand and the posterior temporal bone surface on the other hand. An enlarged vestibular aqueduct is one of the most common inner ear deformities that result in hearing loss during childhood, and its presence should always warrant search for cochlear deficiency.

There are three bony semicircular canals, the vertical and opposite to each other placed superior and posterior semicircular canal and the horizontal placed lateral semicircular canal. They measure about 1 mm in diameter and each stands at right angles to the other two. The upper bony margin of the superior semicircular canal forms a convexity in the petrous roof, the arcuate eminence. The lateral semicircular canal slightly protrudes into the

epitympanum where it is vulnerable for fistulizing epitympanic cholesteatomas. It is in close contact with the midtympanic portion of the facial nerve, which passes along the undersurface of the lateral semicircular canal. Each semicircular canal has an enlargement at one end, forming a bony ampulla that contains the cristae with the vestibular sensory epithelium and that opens in the vestibule. The other nonampullary sides also open in the vestibule but the superior and posterior semicircular canals join to form a common crus, thus resulting in five orifices in the vestibule

The Membranous Labyrinth

The membranous labyrinth is suspended in the osseous labyrinth, and is separated from its bony walls by perilymph except for some places where it is fixed to the walls of the cavity by fibrous bands. The membranous labyrinth also contains fluid, endolymph.

The membranous labyrinth more or less follows the form of the osseous labyrinth except for the vestibule that consists of two membranous sacs, the utricle, and saccule. The utricle lies in contact with the bony elliptical recess and communicates with the semicircular ducts by five orifices. From its anterior wall runs the utriculosaccular duct, which opens in the

endolymphatic duct. The saccule is smaller and globular in shape and lies in contact with the spherical recess. From its posterior wall, the endolymphatic duct is given off, which joins the utriculosaccular duct and passes along the vestibular aqueduct to end in the endolymphatic sac. Both utricle and saccule show a thickening near the elliptical and spherical recess respectively forming the utricular and saccular macula which receive the utricular and saccular filaments of the acoustic nerve.

The semicircular ducts are about one-fourth of the diameter of the osseous canals but are otherwise similar in number and shape. In the ampulla, the wall is thickened forming the transverse septum that also receives the filaments of the acoustic nerve.

Both vestibule and semicircular canals play an important role in the vestibular functions of the inner ear. In the maculae of the utricle and saccule and in the transverse septa of the ampullae of the semicircular ducts, we find hair cells connected to the filaments of the vestibular nerve, a division of the acoustic nerve. The utricle and saccule that are respectively more or less in the horizontal and parasagittal plane have— besides hair cells—also otoliths which allow linear acceleration detection respectively in the axial and coronal

imaging planes and generate otolith-ocular reflexes and otolith-body or righting reflexes. The semicircular canals detect angular acceleration and exert direct control over the eyes to compensate for head movement by the vestibulo-ocular reflex.

The ductus cochlearis or scala media also follows the bony canal of the cochlea as a spirally arranged tube. It consists of the basilar membrane that extends from the osseous lamina spiralis and the more delicate vestibular membrane or Reissner's membrane, forming the floor and the roof of the duct, respectively. The scala media lies between the superiorly scala vestibule and the inferior scala tympani and contains the spiral organ of Corti. This complex organ consists of thousands of auditory nerve receptors, each with their own hair cell which transforms mechanical pressure vibrations into action potentials leading to electrical signaling to the auditory cortex, resulting in hearing

PATHOGENESIS OF CHOLESTEATOMA

Theories of Cholesteatoma formation

Basal cell Hyperplasia (proliferation) theory

First proposed by Lange in 1925, and supported by Reudi in 1978. The basal cells of germinal layer of skin proliferate under the influence of infection and lay down keratinizing squamous epithelium.

Habbermann's Invasion (immigration) theory

First prescribed by Habbermann and Bezold. According to this theory: The epithelium from the meatus or outer drum surface grows into the middle ear through a pre-existing perforation especially of the marginal type where part of annulus tympanicus has already been destroyed.

Implantation theory

This theory implies formation of cholesteatoma as a result of accidental impaction of squamous epithelium into the tympanic cavity following ear surgery (iatrogenic), accidental trauma, or blast injury.

Whittmack's Invagination (retraction pocket) theory

It is the most widely accepted among the theories. According to this theory primary acquired cholesteatoma is started by retraction pocket in the region of pars flaccida caused by negative pressure of the middle ear. This causes accumulation of keratinized cells leading to cholesteatoma formation. Recently, Jackler et al. criticized the invagination theory in several respects. Their criticism was depending on observing the results of other studies and can be summarized in the following points: first, the occurrence of cholesteatoma was not reduced after cleft palate repair or insertion of ventilation tubes in cleft palate patients. Second, observing healthy and well-functioning Eustachian tube in some cholesteatomatous ears. Third, surgical obliteration of Eustachian tube after some skull base and otologic surgeries didn't lead to cholesteatoma formation. Fourth, in a study done by Roland et al. , the insertion of ventilation tympanostomy tubes was not effective in lowering the incidence of cholesteatoma in children. Finally that the negative middle ear pressure, although it can lead to TM retraction, it doesn't have enough power to maintain further progression of cholesteatoma pouch

HISTOLOGY OF CHOLESTEATOMA

Histologically stratified keratinizing squamous epithelium, subepithelial fibroconnective or granulation tissue, and keratin debris are seen. The essential diagnostic feature is the keratinizing squamous epithelium.Tthe presence of keratin debris alone is not diagnostic of a cholesteatoma. The keratinizing squamous epithelium is cytologically bland, and it shows cellular maturation without evidence of dysplasia. In spite of its benign histology, cholesteatomas are ‘‘invasive,’’ and they have widespread destructive capabilities. The destructive properties of cholesteatoma result from a combination of interrelated reasons, including mass effect with pressure erosion of the surrounding structures and the production of collagenase, which has osteodestructive capabilities. Collagenase is produced by both the squamous epithelial and the fibrous tissue components of the cholesteatoma.

MECHANISMS OF BONE RESORPTION IN CHOLESTEATOMA

Different theories are postulated regarding mechanisms of bone erosion in cholesteatoma:

1) Pressure theory

The osteoclastic bone resorption occurs due to adequate and constant pressure by cholesteatoma mass.

2) Chemical activity and bone resorption

Chemical activity of cholesteatoma in bone resorption has been suggested since 1950s. Hydroxyapatite. Nguyen et al. investigated the role of pH in bone resorption in cholesteatoma and found that the pH of keratin debris was acidic and lower than the antrum mucosa. So, they concluded that acidic pH in cholesteatoma may be one of the factors that promote bone erosion by decalcification of the adjacent bony structures.Role of bacterial infection, bacterial biofilms, and lipopolysaccharide Bacterial biofilms were found to be very common in chronic suppurative otitis media and middle ear cholesteatomas. The keratin layer of cholesteatoma is an ideal environment for biofilm production. The presence of bacterial biofilms in cholesteatoma

mediates the host response in the form of chronic inflammation, proliferation, and bone resorption. Pseudomonas aeruginosa is the most common organism isolated from infectious middle ear diseases followed by Staphylococcus aureus and other gram-positive aerobes. Pseudomonas stimulates production of interleukin (IL)-1β, IL-6, prostaglandin (PG) E2, and tumor necrosis factor alpha (TNF-α) from macrophages and monocytes with resultant increase in inflammatory activity. Jung et al. performed an experimental study to investigate the role of PA in the aggressiveness of induced cholesteatoma in gerbils and found that infected cholesteatomas showed more expansion and became more aggressive than uninfected control subjects.

Inflammatory mediators

Inflammatory mediators initiate chronic inflammation and recruitment of osteoclasts and hence induce bone resorption in cholesteatoma. These mediators include.

RANK-RANKL-OPGsystem

Recently, it was proved that the receptor activator of nuclear factor (NF)-kappa B, receptor activator of NF-kappa B ligand and osteoprotegerin (RANK-RANKL-OPG) system plays a key role in bone metabolic disorders , including bone resorption in the middle ear cholesteatoma. By immunohistochemistry (IHC)

Role of nitrous oxide

Nitrous oxide (NO) is a potentially important mediator of bone resorption. Jung et al. studied the role of NO in cholesteatoma induced bone resorption through both in vitro and in vivo experiments. They found that all nitric oxide synthase (NOS) isoforms (I, II, and III) were expressed in an in vivo model of cholesteatoma induced bone resorption with particular upregulation of NOS III. Furthermore, exogenously administered nitric oxide enhanced osteoclast activation in vitro.

Enzymatic activity in cholesteatoma

Collagenase attacks the intact collagen molecule, making it susceptible to further digestion by other proteases with subsequent bone resorption . The production of collagenase was enhanced by the interaction between epithelial cells and mesenchymal cells. N-acetyl-β-hexosaminidase destructs bone in cholesteatoma

Proliferation markers and relation to bone destruction

Hyperproliferation of keratinocytes with abundant production of keratin in the tympanic cavity under the effect of chronic inflammation is the characteristic hallmark of cholesteatoma. This hyperproliferative activity can be used as a marker or predictor for the aggressive potential of cholesteatoma.

Role of prostaglandins

Eicosanoids are arachidonic acid metabolites. They include PGs and leukotrienes. PGs play an active role in the pathogenesis of chronic OM with bone resorption. Levels of PG E2 and thromboxane E2 were found to be higher in cholesteatoma than in granulation tissue. An experimental in vitro

study revealed that endotoxin and PG E2 stimulate the growth of epidermal basal cells of cholesteatoma.

Cytokines

Cytokines play a significant role in immune response and inflammation. Among the involved cytokines and considered to have an intimate relation with bone destruction are TNF-α, IL-1, IL-6, matrix metalloproteinase 2 (MMP 2), and matrix metalloproteinase 9 (MMP 9).

Tumor necrosis factor alpha: TNF-α is considered an autocrine growth modulator that stimulates osteoclast induced bone resorption and inhibits collagen synthesis by promotion of the activity of collagenases, acid phosphatases and proteases. Iino et al. found that cholesteatoma debris was a potent stimulus for production of TNF from cultured human monocytes/macrophages. The serum levels of TNF-α, as well as its level in cholesteatoma debris, were found to higher in patients with cholesteatoma than controls and such levels are positively correlated with the degree of bone destruction.

Interleukin-1: An osteoclast activating factor and it can induce fibroblasts to produce PGs and collagenase enzymes .

Matrix metalloproteinase 2 and matrix metalloproteinase 9: They are group of proteolytic enzymes capable of degrading the extracellular matrix. Higher expression of MMP 2 and MMP 9 in cholesteatoma tissue in comparison to the normal canal skin was proved by many authors and by the use of different techniques such as enzyme-linked immunosorbent assay, zymography, immunofluorescence, IHC, and reverse transcription-polymerase chain reaction for gene expression. Furthermore, Juhasz et al. revealed that increased expression of MMP 9 and tenascin was positively correlated with the aggressiveness of cholesteatoma. Thus, they could be used as a reference to detect the bone destructive capacity of cholesteatoma .

Role of osteoclasts and other cells in bone resorption

Osteoclast mediated bone resorption is one of the most important pathologic event in cholesteatoma. Osteoclasts including substance P which promotes osteoclastogenesis via activation of NF-kappa B.. Other osteoclast

stimulating factors include arachidonic acid metabolites, interleukins (IL-1α, 1β, and IL-6), TNF-α, interferon-β, and parathyroid-hormone related protein. Those factors are stimulated by local pressure exerted by cholesteatoma itself as well as the degree of inflammatory process. Concerning other cells, Berger et al. in 1985 investigated the role of mast cells and found a positive role of these cells in destructive potential in cholesteatoma. Furthermore, the cell mediated immunity appeared to have an essential role in cholesteatoma pathogenesis as well as its destructive behavior particularly T-lymphocytes. IHC studies of immune cell infiltrate in cholesteatoma tissue emphasized that T-cells (CD3, CD6), histiocytes (CD68) markers predominated in the stroma of cholesteatoma specimens as compared to control tissues. The immune cells express toll like receptors 2, 3, and 4 which were studied in cholesteatoma tissue and revealed higher expression than normal skin

RADIOLOGICAL ANATOMY OF TEMPORAL BONE-HRCT

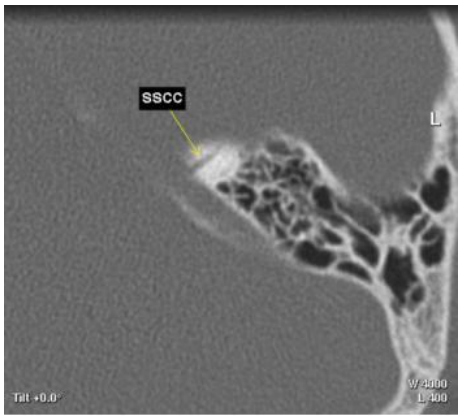
Original plane of sections, the scan angle is chosen such that it covers the temporal bone but avoids the lens of the eye.

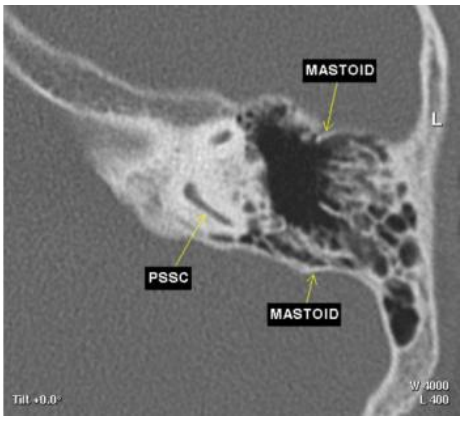
Nowadays, the introduction of multidetector spiral CT Scanner has meant that an entire volume of the temporal bone can be visualised by passing the scanner just once in one plane. The data set can be sectioned in virtually any plane.

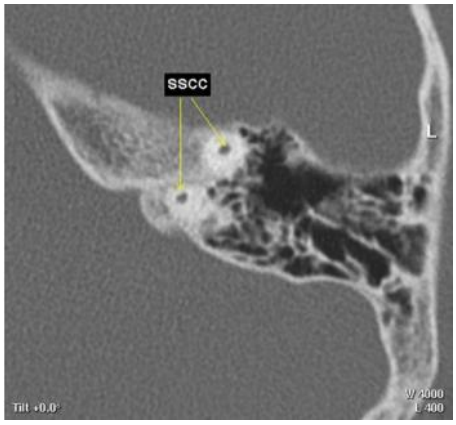
The plane of the reformatted image is not governed by ease of patient positioning, but by the optimal plane for visualizing a structure. Since the plane of the final image does not depend on the original scan angle, the scan needs to be performed avoiding the lens of the eyes.

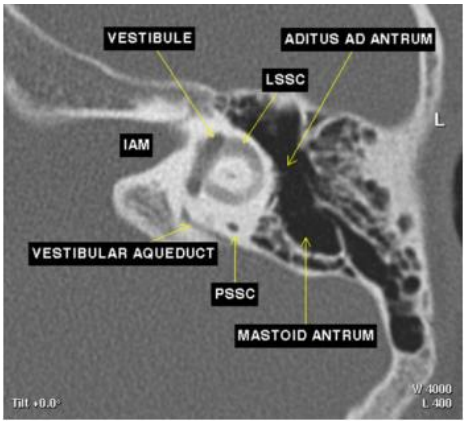
The following images detail the anatomy of the temporal bone in various planes of section:-

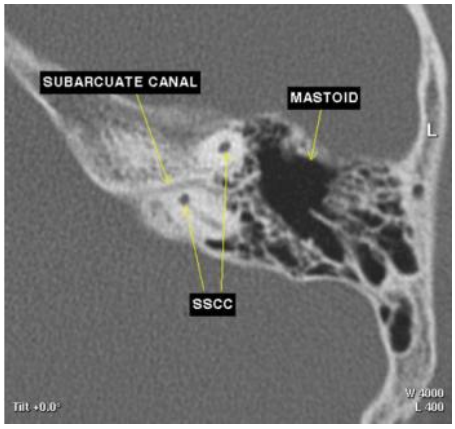
AXIAL SECTIONS FROM SUPERIOR TO INFERIOR

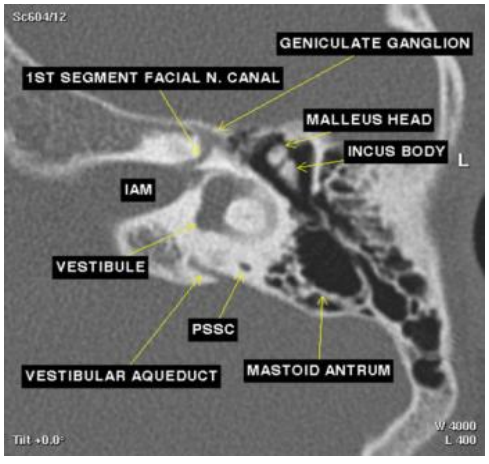


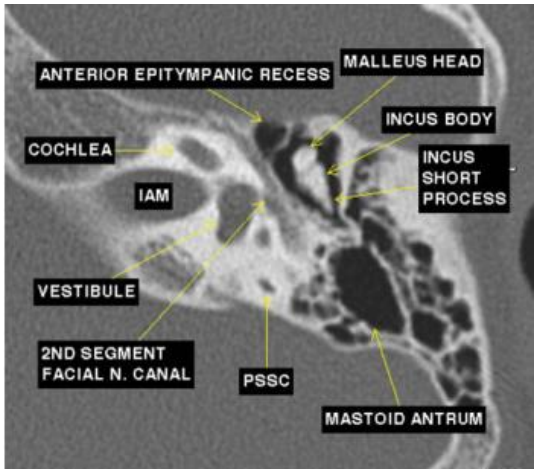


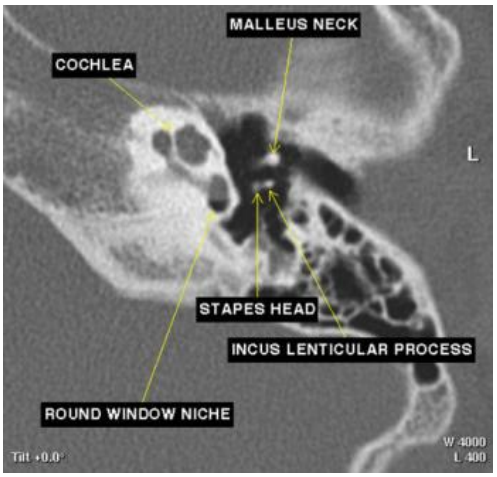









ANTERIOR EPITYMPANIC RECESS
MALLEUS HEAD
INCUS BODY
COCHLEA
INCUS SHORT PROCESS
IAM
VESTIBULE
2ND SEGMENT FACIAL N. CANAL
PSSC
MASTOID ANTRUM


MALLEUS NECK
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STAPES HEAD
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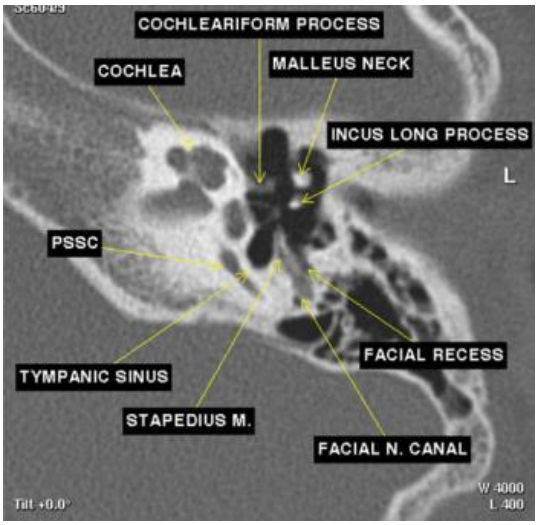
COCHLEARIFORM PROCESS
COCHLEA
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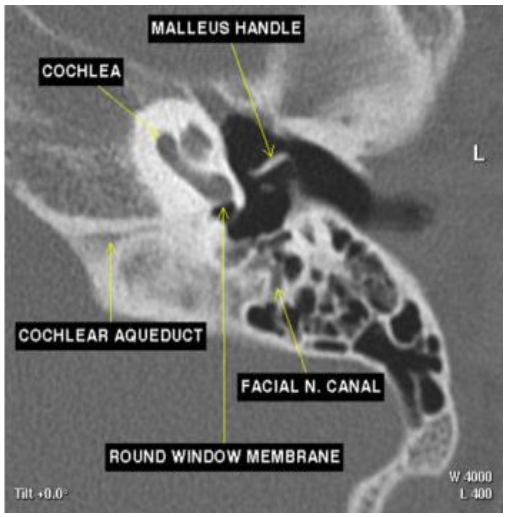
PSSC
TYMPANIC SINUS
FACIAL RECESS
STAPEDIUS M.
FACIAL N. CANAL
Tilt +0.0°
W 4000
L 400


MALLEUS HANDLE
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COCHLEAR AQUEDUCT
FACIAL N. CANAL
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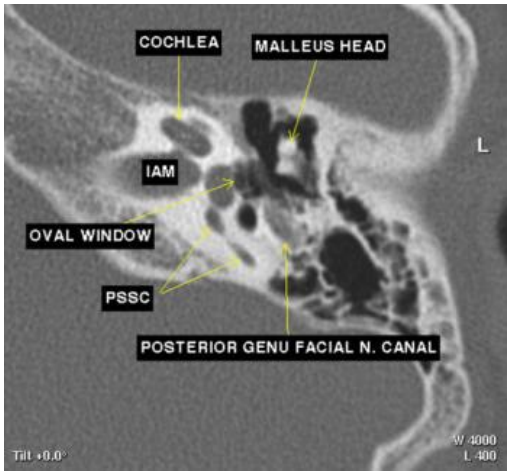
COCHLEA
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Tilt +0.0°
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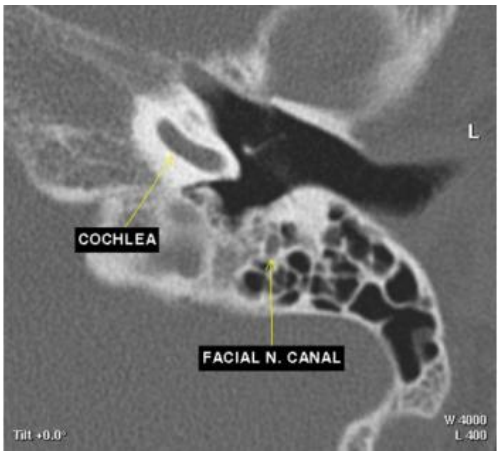
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COCHLEA
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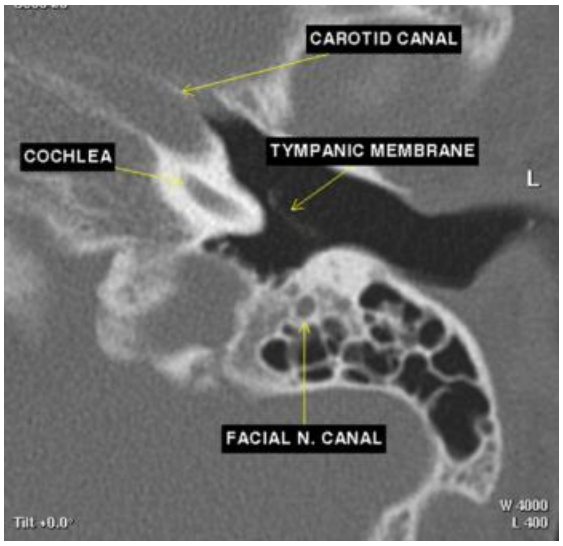
CAROTID CANAL
COCHLEA
TYMPANIC MEMBRANE
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FACIAL N. CANAL
Tilt +0.0°
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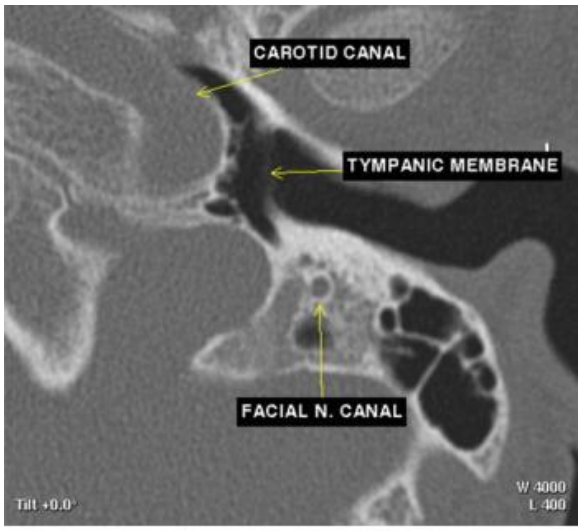
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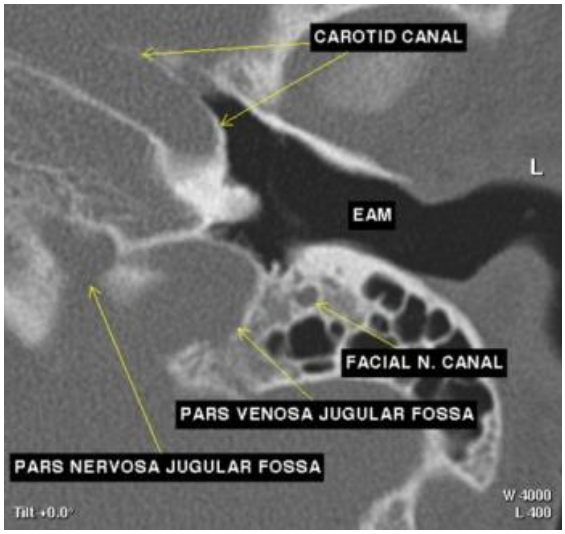
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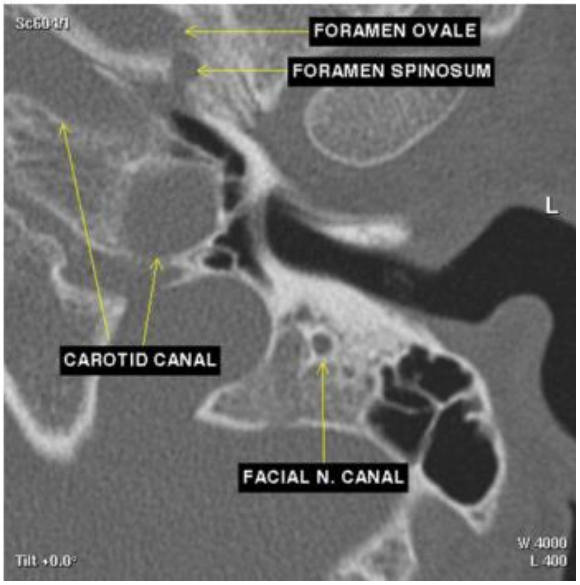
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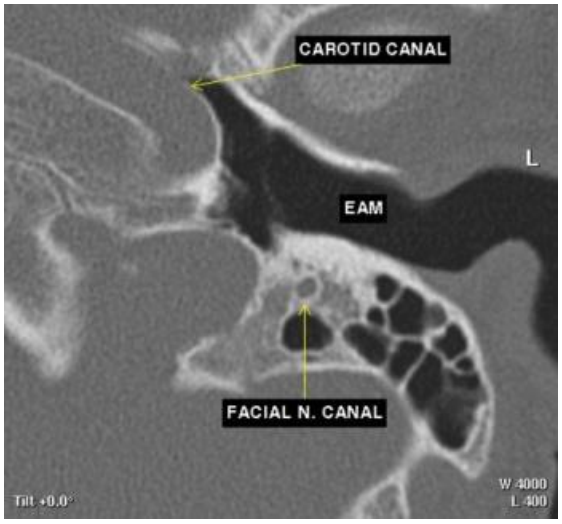
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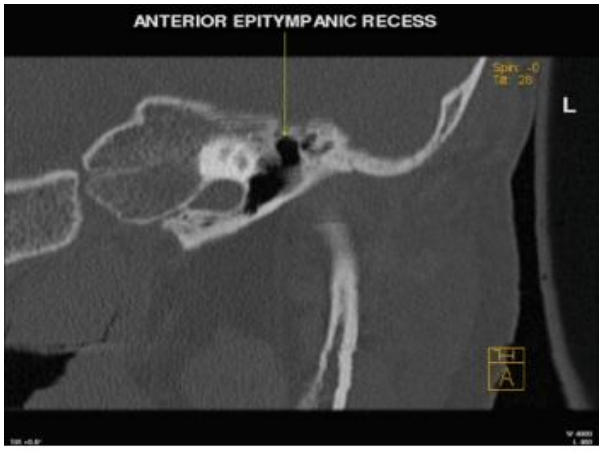

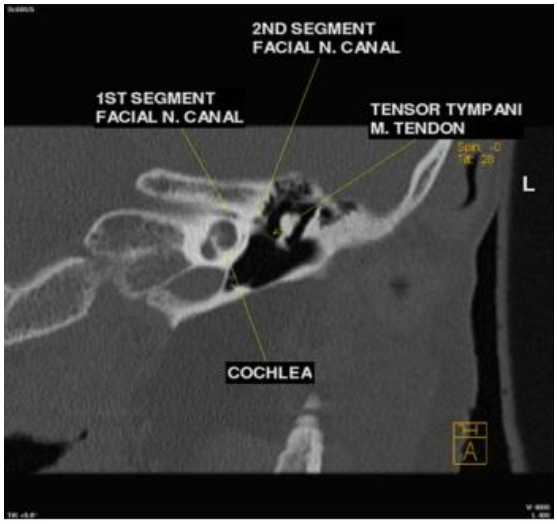

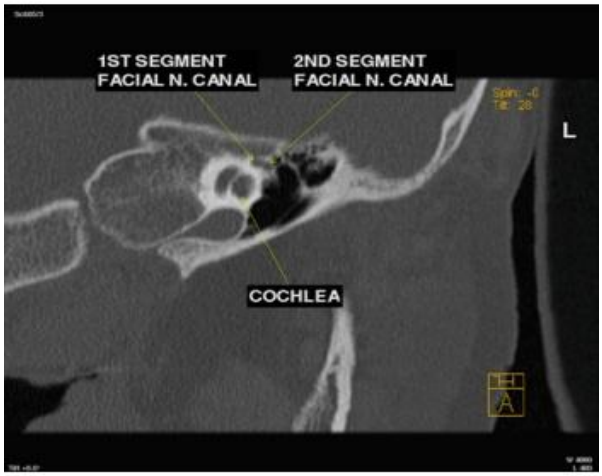

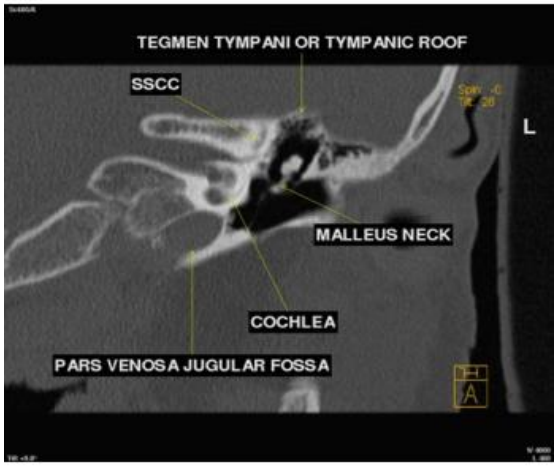

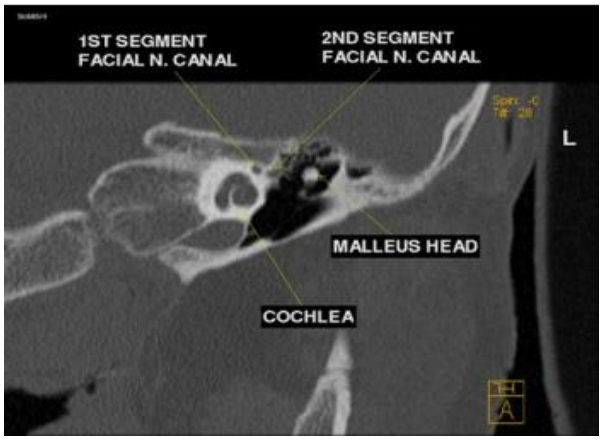

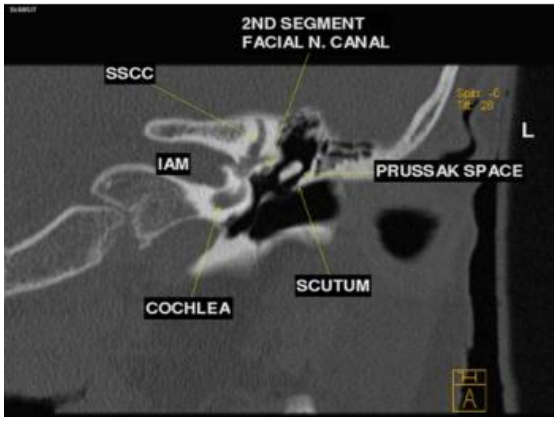

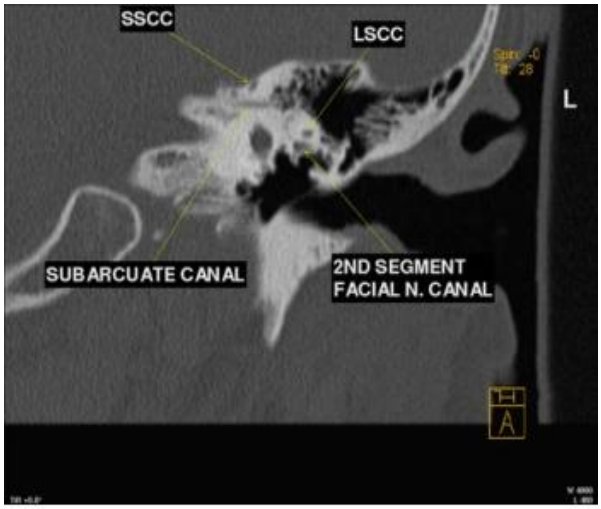
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LSCC
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2ND SEGMENT
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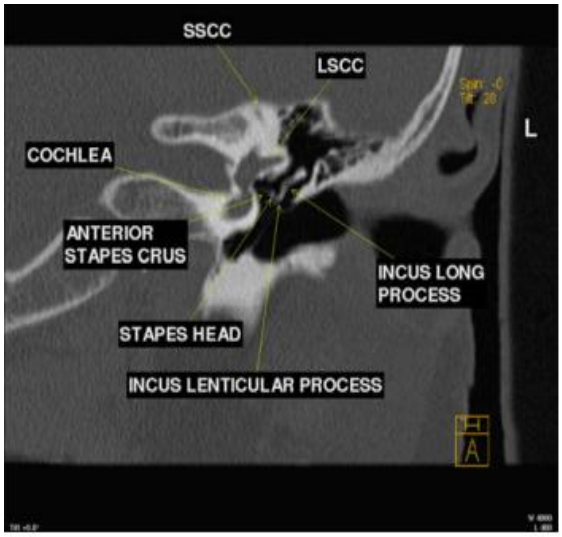
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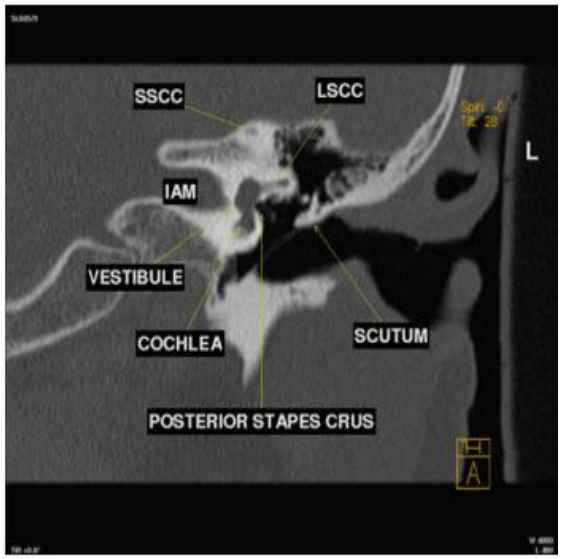
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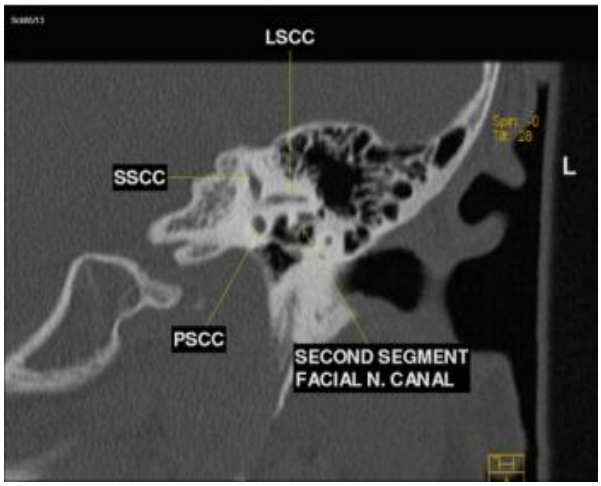
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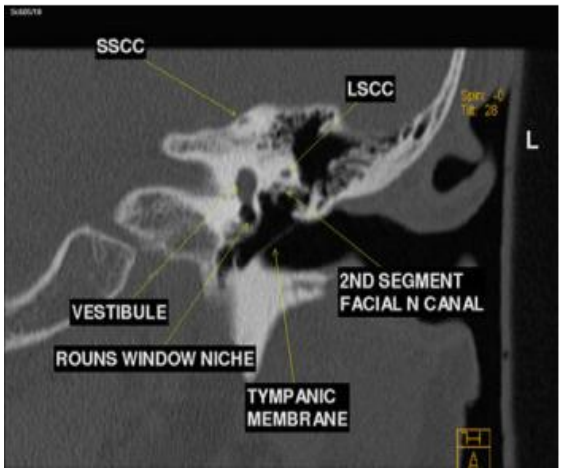
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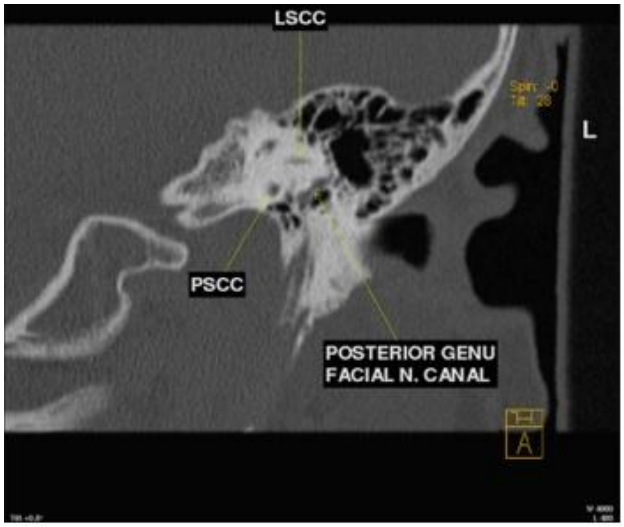
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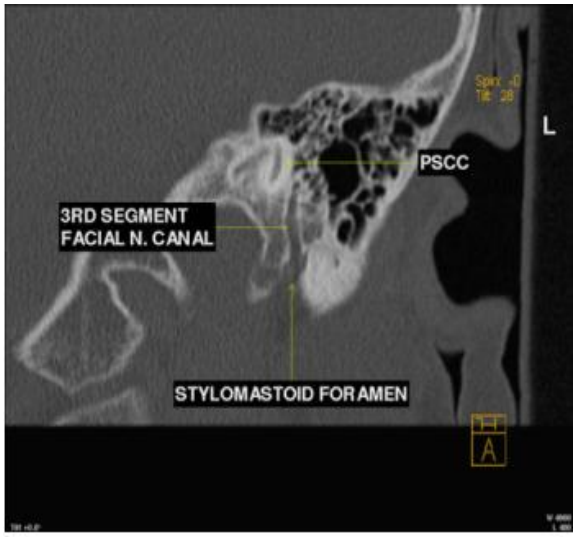
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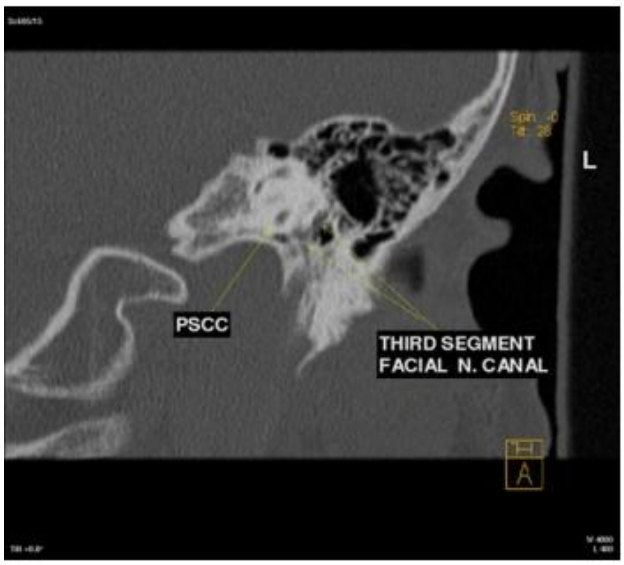
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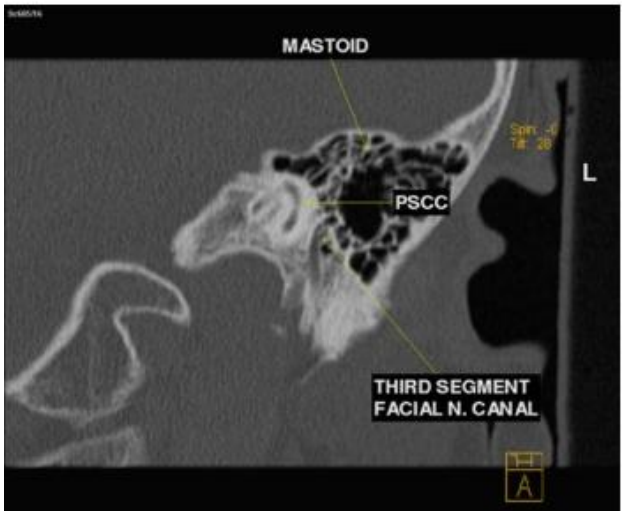
MASTOID ROOF
L
A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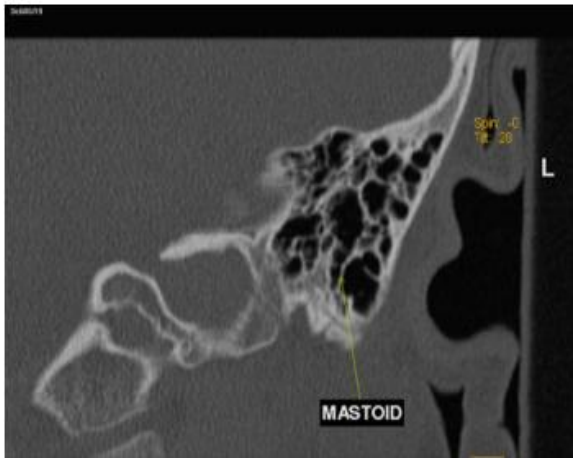
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IMAGING IN CHOLESTEATOMA

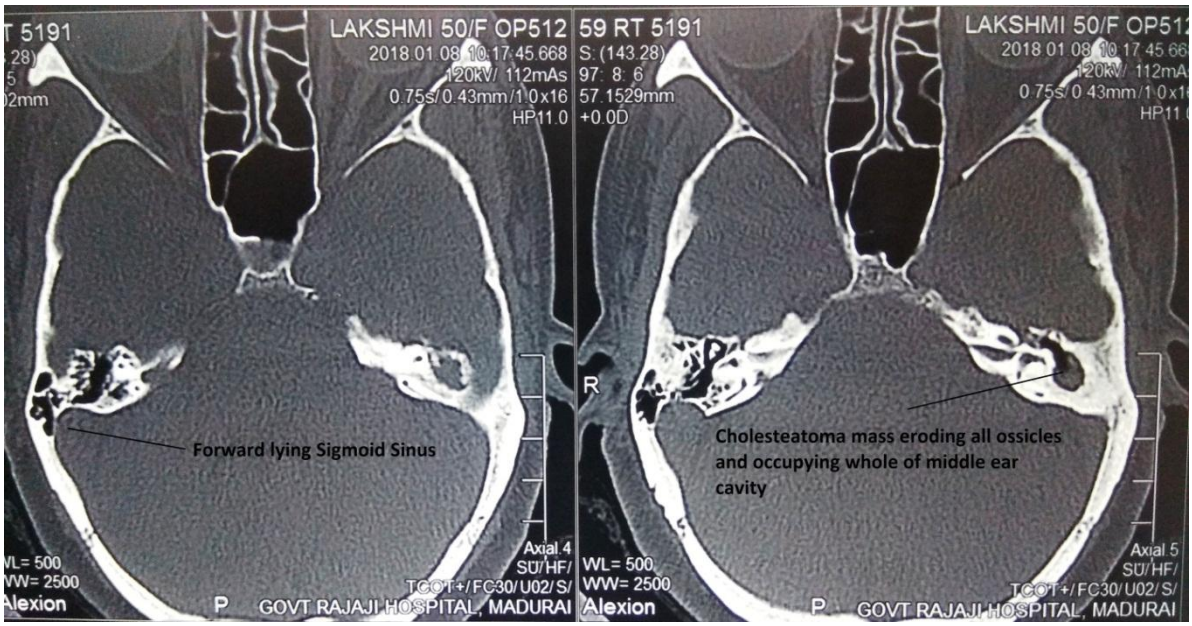


Figure 5 Anteriorly placed Sigmoid sinus

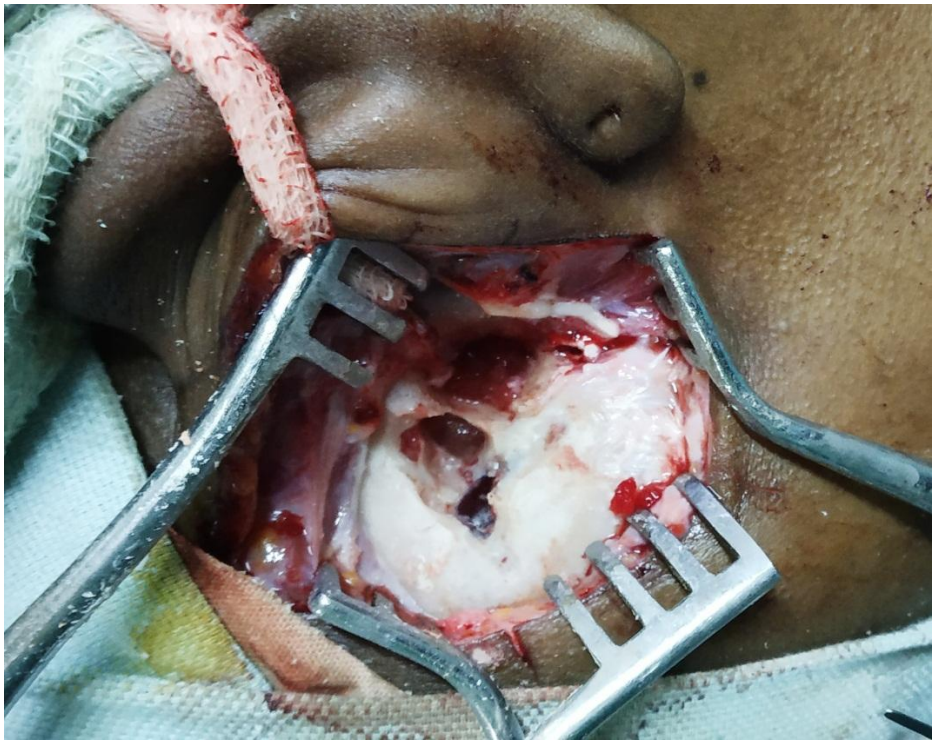


Figure 6 Anterior lying sigmoid seen intraoperatively

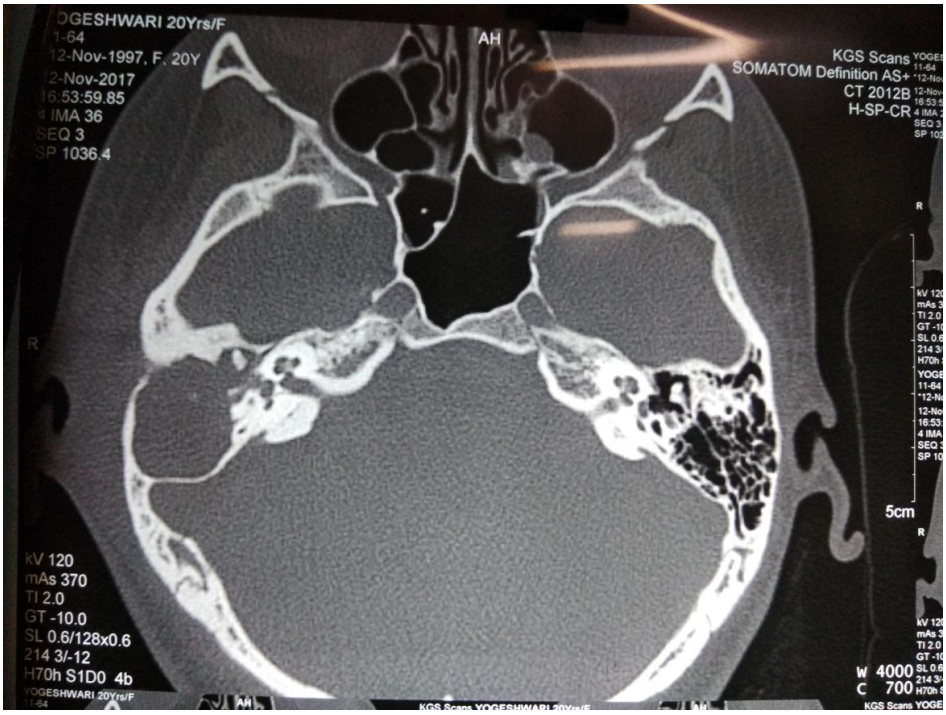


Figure 7 Cholesteatoma mass causing automastoidectomy

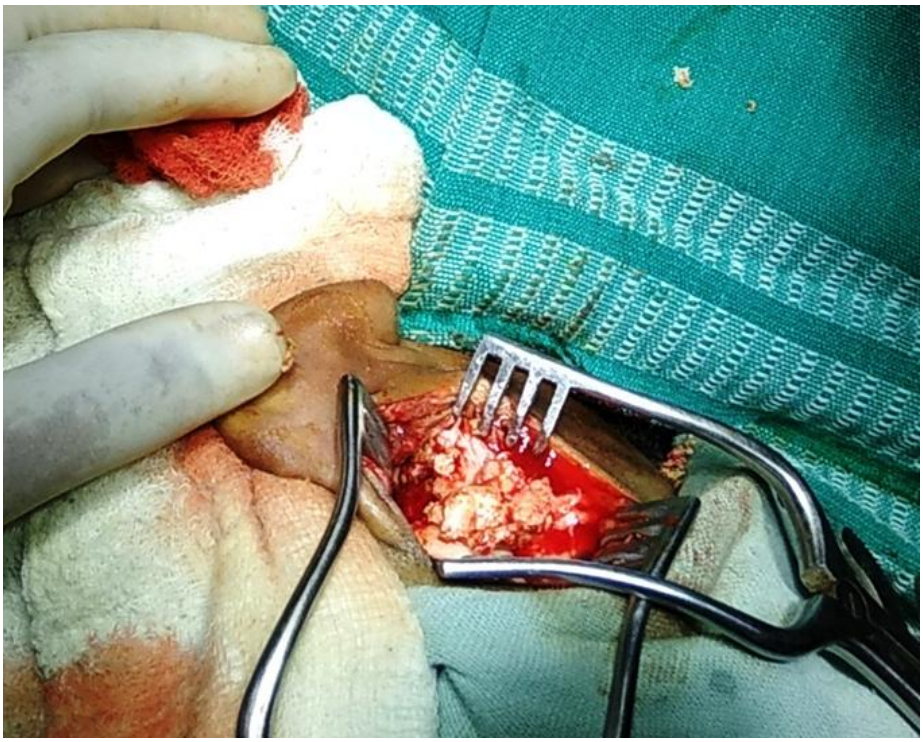


Figure 8 Same patient intraoperatively, showing cholesteatoma mass in mastoid antrum

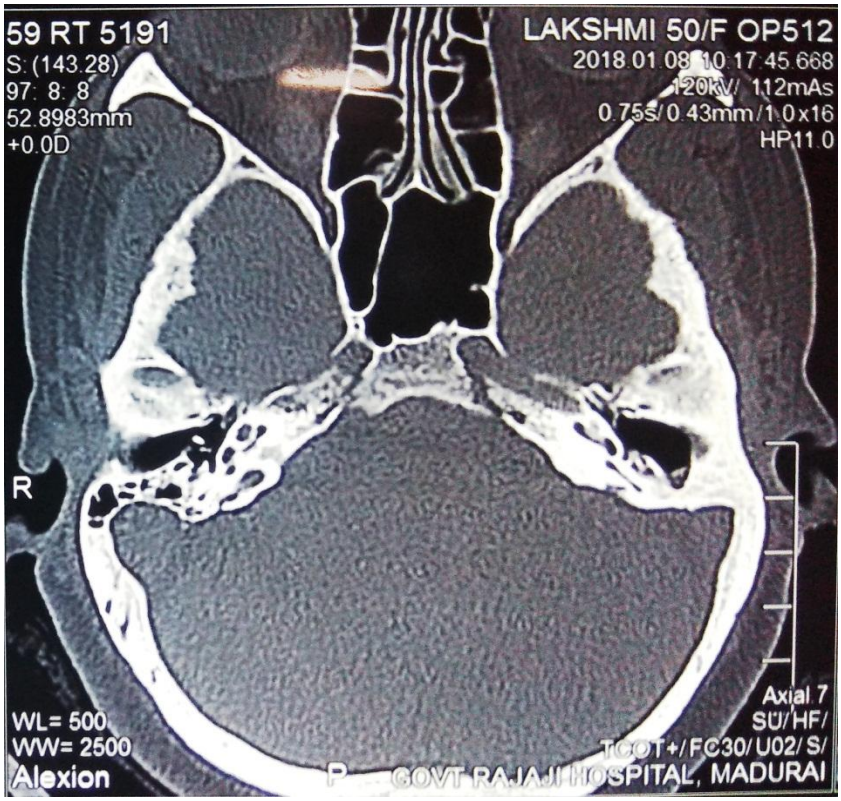


Figure 9 Cholesteatoma causing ossicular destruction

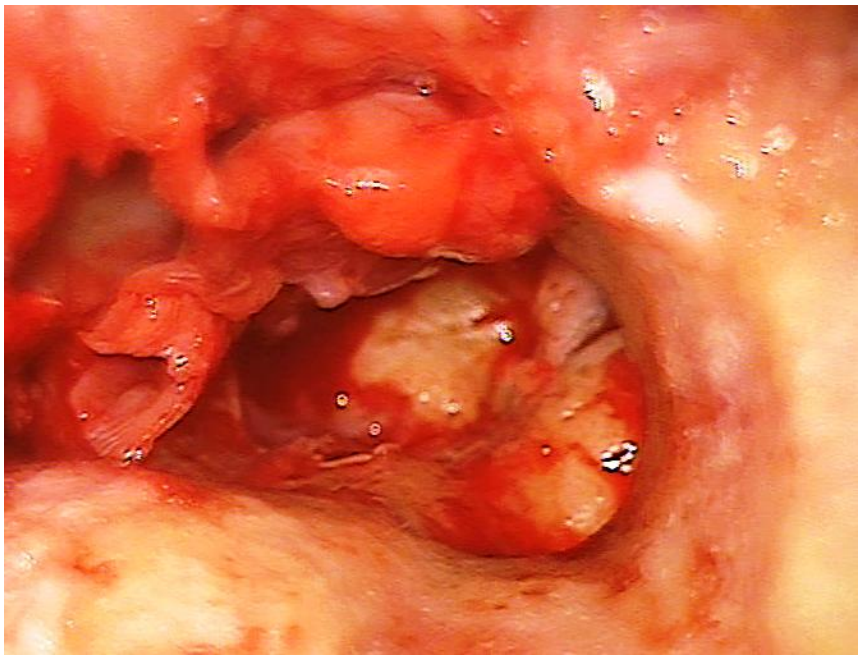


Figure 10 Intraoperative picture showing complete absence of ossicular chain

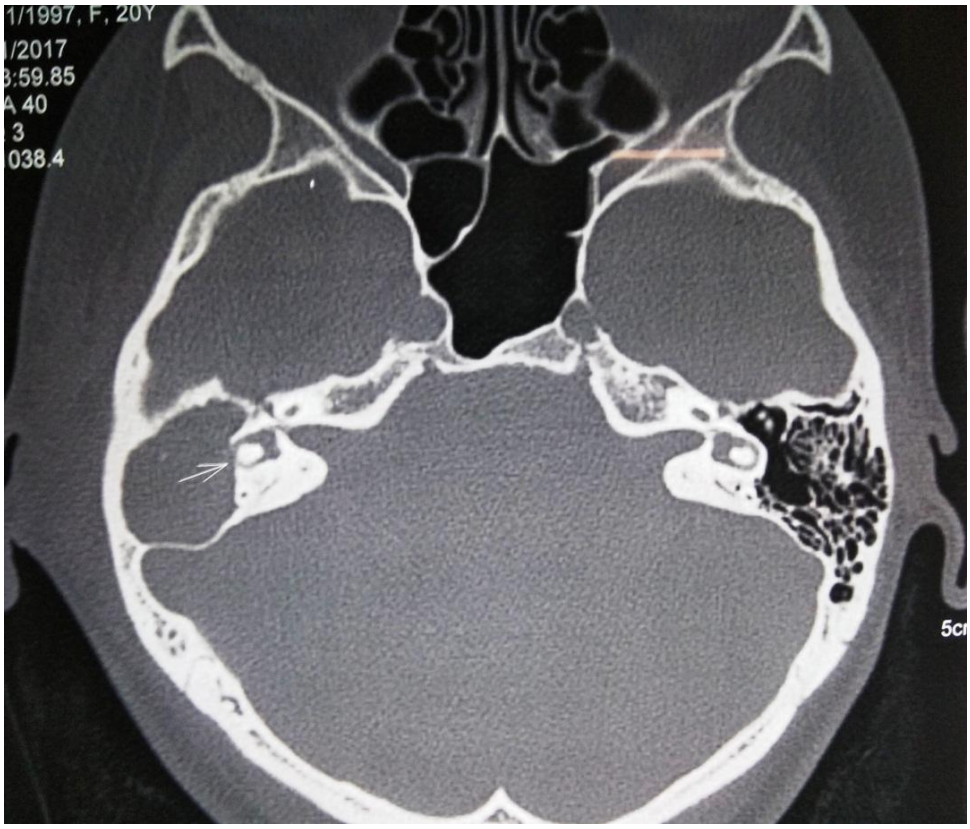


Figure 11 HRCT showing impending LSCC fistula

OBSERVATIONS AND RESULTS

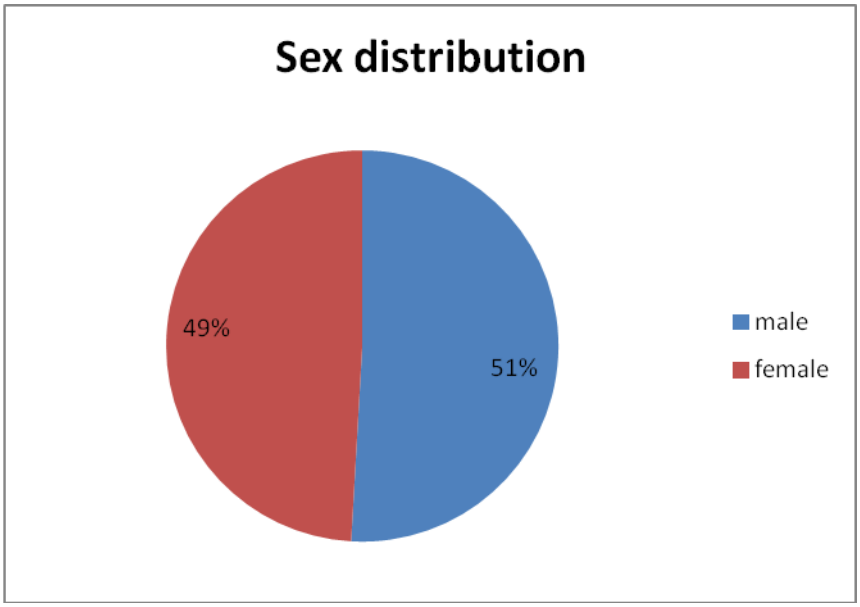
The prospective cohort clinical study was carried out on 55 patients attending ENT OPD, Govt.Rajaji hospital, Madurai in the period of one year from October 2017 to September 2018.

The ages of the patients ranged from 9 to 55 years with mean age of 27.3 years.

The minimum age in the study was 9 years, and the maximum age was 55 years.

The maximum numbers of patients were found in the age group of 9 to 25 years.

There were 28 male (51%) and 27 female (49%) patients showing male preponderance with male to female ratio of 1:1.03.

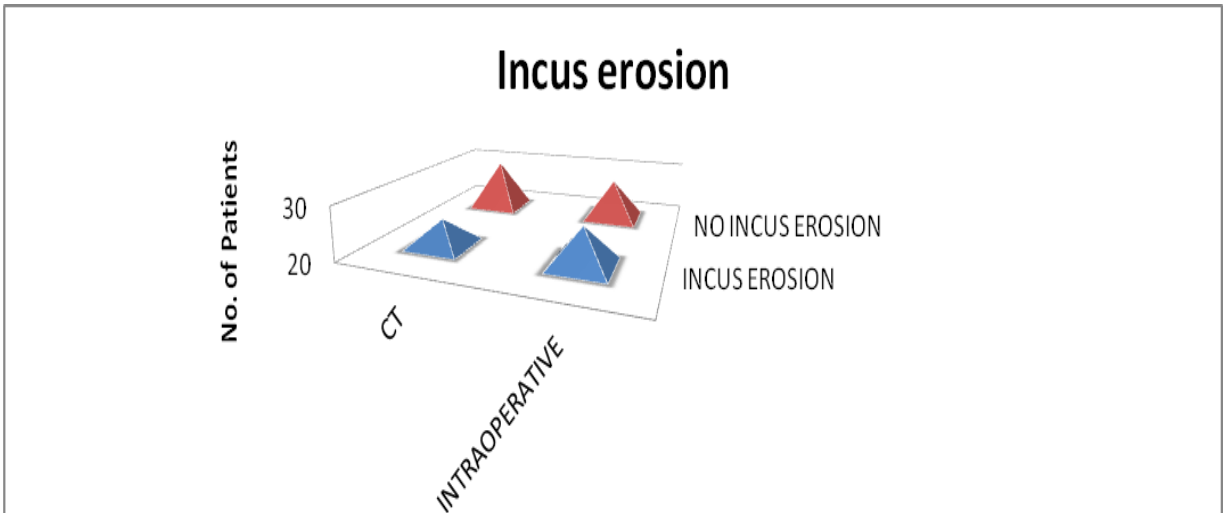


AGE AND SEX DISTRIBUTION OF CASES:

AGE	MALE	FEMALE	TOTAL
5 - 25	14	16	30
26 - 40	9	9	18
41 - 55	5	2	7
Total	28	27	55

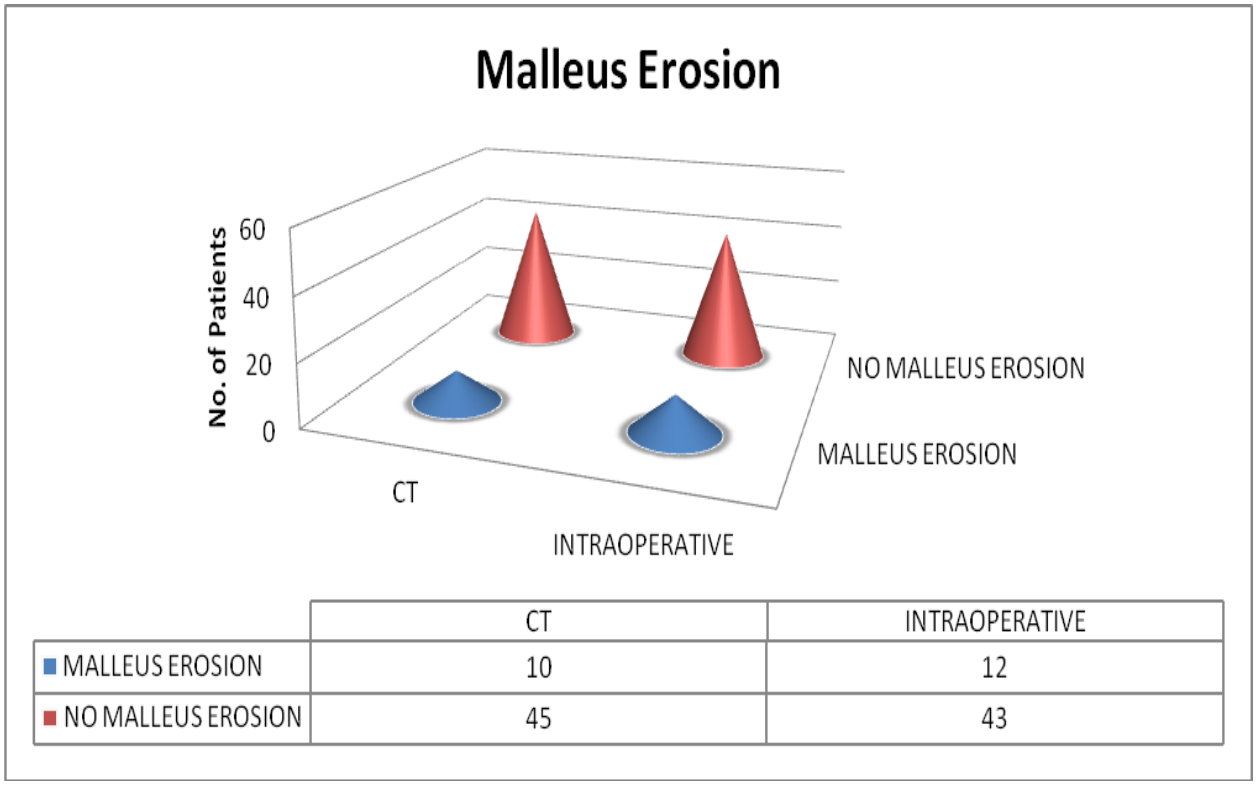
Scutum erosion was visualized in all patients and similar findings intraoperatively.

Incus appeared eroded on CT scan in 25(45.45%) of cases, whereas intraoperatively it was seen in 27(49.09%).



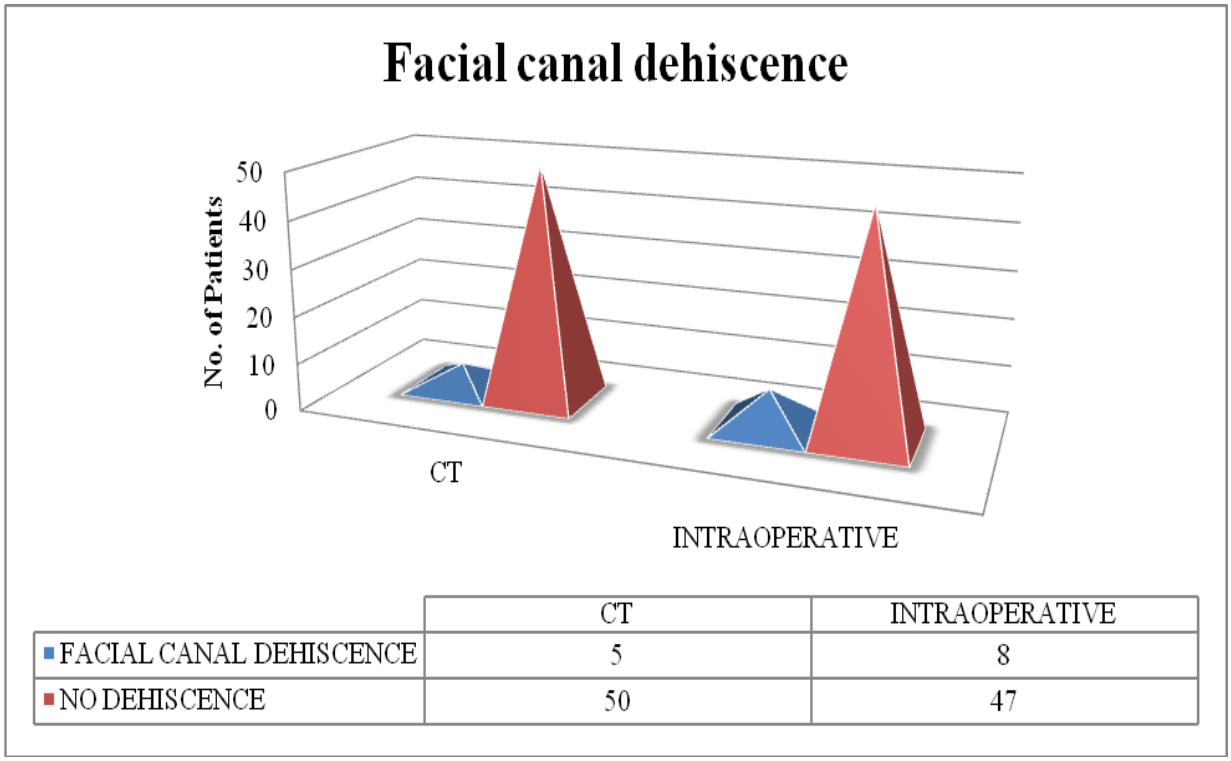
	CT	INTRAOPERATIVE
INCUS EROSION	25	27
NO INCUS EROSION	30	28

Malleus erosion was reported by CT in 10(18.18%), and whereas intraoperatively it was seen in 12(21.81%)



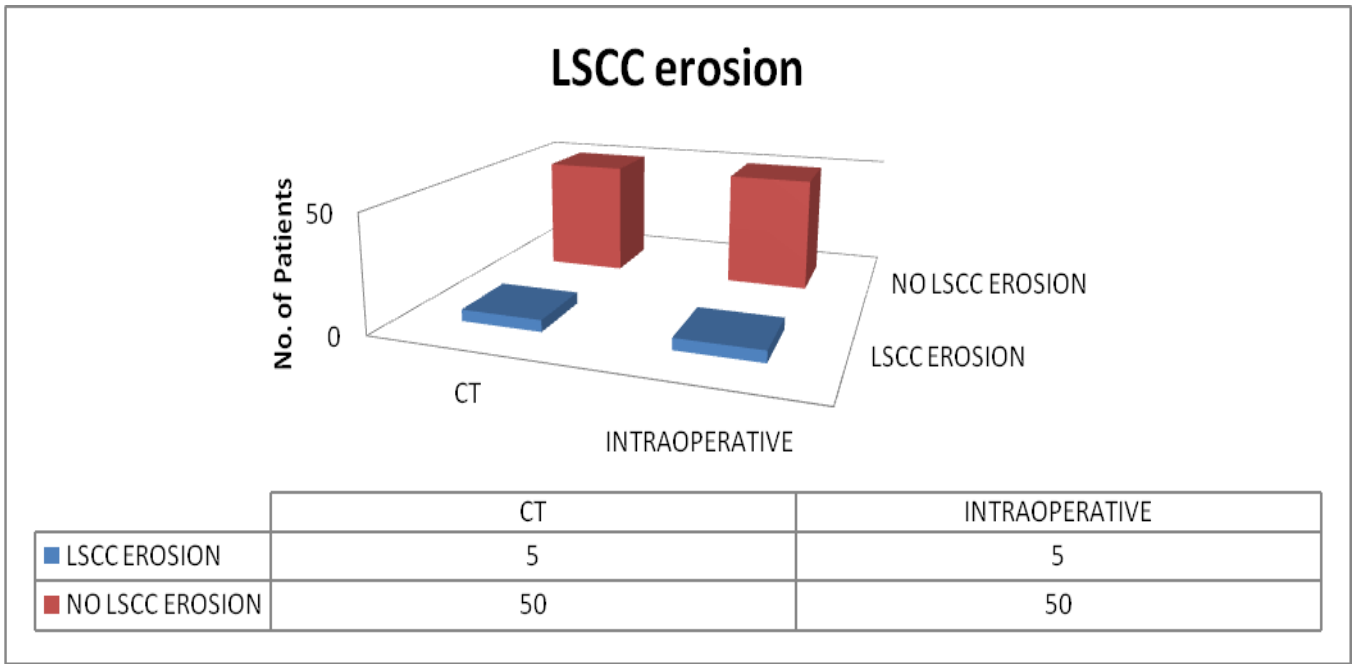
	CT	INTRAOPERATIVE
MALLEUS EROSION	10	12
NO MALLEUS EROSION	45	43

Fallopian canal erosion was depicted by CT in 5(9.09%) cases, whereas intraoperatively it was seen in 8(14.54%)



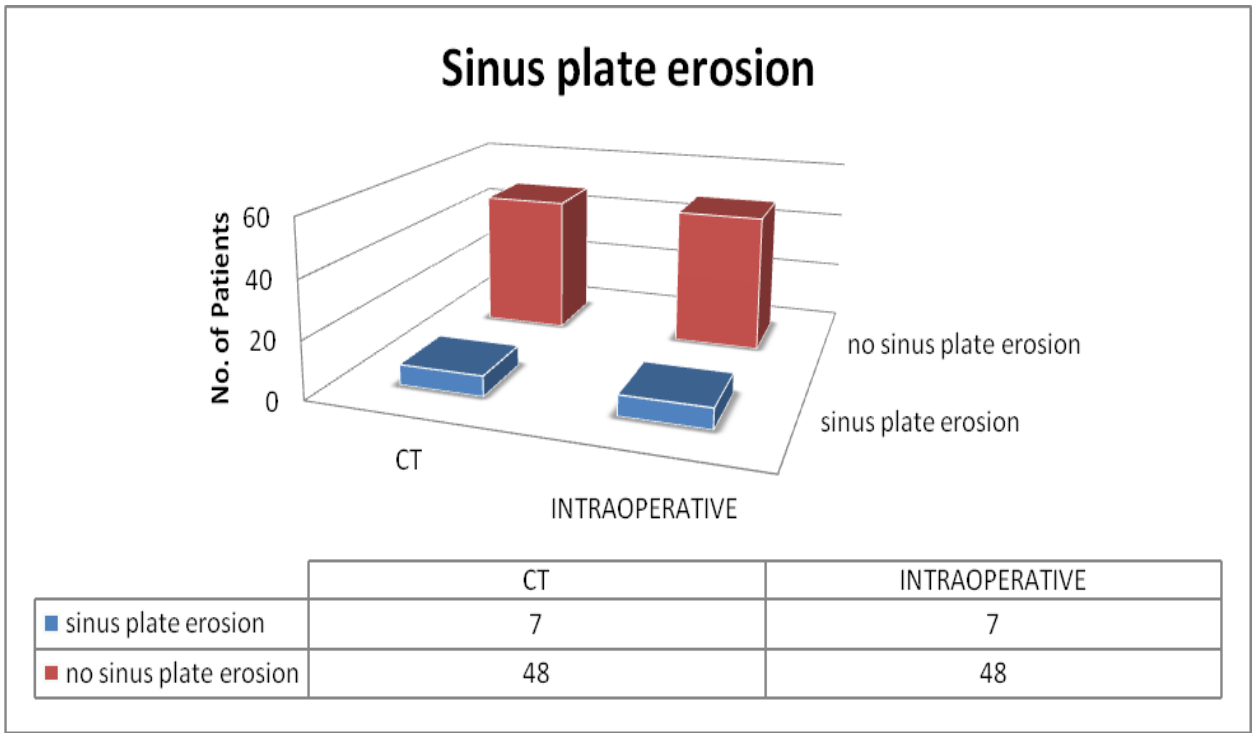
	CT	INTRAOPERATIVE
FACIAL CANAL DEHISCENCE	5	8
NO DEHISCENCE	50	47

Erosion of lateral semicircular canal was reported only in5(9.09%) patients same intraoperatively.



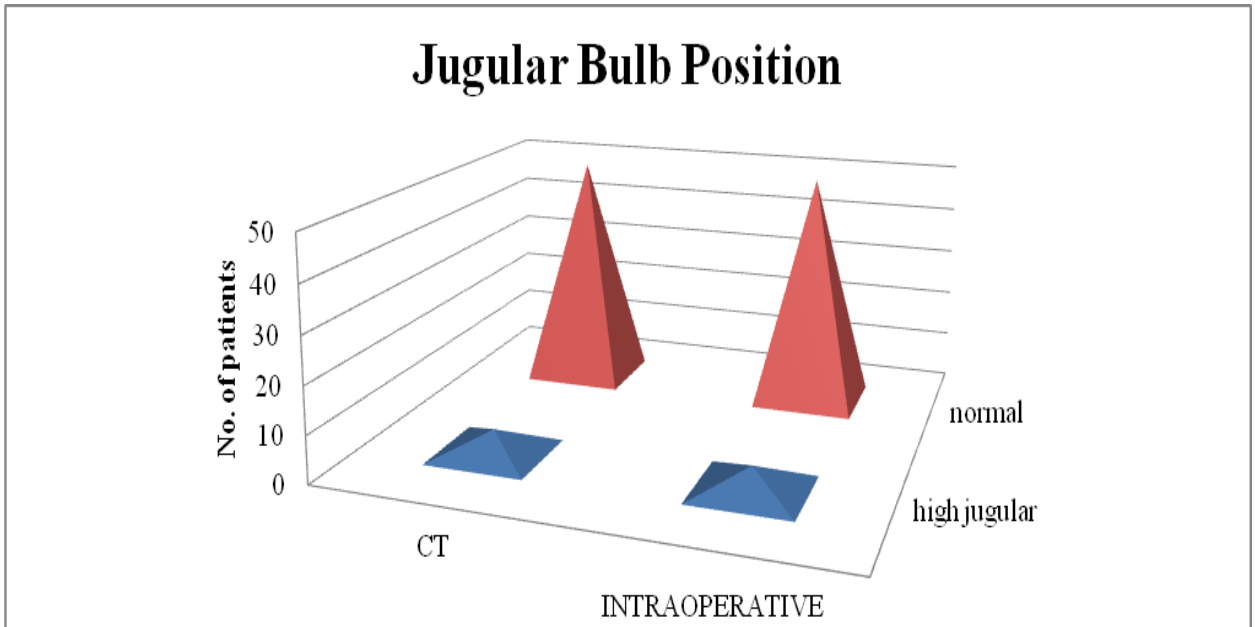
	CT	INTRAOPERATIVE
LSCC EROSION	5	5
NO LSCC EROSION	50	50

Sigmoid plate erosion was seen both on CT and during surgery in 7(12.72%) cases.



	CT	INTRAOPERATIVE
sinus plate erosion	7	7
no sinus plate erosion	48	48

High Jugular was seen in 5(9.09%) of the patients which were confirmed intraoperatively in all 5 patients.



	CT	INTRAOPERATIVE
high jugular	5	5
normal	50	50

DISCUSSION

HRCT is considered as imaging modality of choice for anatomical and pathological evaluation of temporal bone,prior to surgery, including chronic otitis media (Cholesteatoma).In this study, incus was most commonly affected ossicle followed by malleus and stapes. The sensitivity of HRCT for detecting malleus erosion was 83.3 %, incus was also 92.5%. Similarly, the specificity of CT scan for detecting malleus erosion was 100%, incus erosion was also 100%. These findings are consistent with the findings of Chee et al. and in contrast to study by Tatlipinar et al. who observed sensitivity of 62.8% and specificity of 85.7% for the same. In our series, HRCT had a sensitivity of 100% and specificity of 100% with regards to detection of erosion of tegmen plate, which is comparable to study by Jackler et al.Sirigiri et al., O'Reily et al. and Jackler et al. were able to diagnose dehiscence in the horizontal part of facial canal with a sensitivity of 62.5% and specificity 100%. However, Mafee et al. found CT to be very accurate in the diagnosis of erosion of facial canal. In the present study, erosion of the horizontal part of the facial canal was correctly diagnosed in five cases out of eight with a sensitivity of 62.5% and specificity of 100%.We found a very 100%

sensitivity and 100% specificity of CT scan in detecting sigmoid plate erosion. This finding is similar to study by Rogha et al. Conversely, Tatlipinar et al. reported a relatively low sensitivity of 33% and specificity of 100%. Variable results have been reported in literature with regard to ability of CT scan in detection of lateral semicircular canal. Rogha and colleagues reported sensitivity of 75% and specificity of 87.5%.8 On the other hand, Sirigiri et al. reported a sensitivity of 100% and specificity of 94%.12 We found that the sensitivity of CT in detecting lateral semicircular canal erosion was 100%and specificity was also100%. The variability in impression about lateral semicircular canal fistulization could be due to volume averaging of these structures with adjacent soft tissues. These findings highlight the fact that, althoughHRCT temporal bone is helpful for diagnosing chronic otitis media, the findings must be interpreted cautiously in view of its' limitations.The results of our study show that high resolution computed tomography of temporal bone gives precise information about the location and extent of disease. The sinus tympani and facial recess, known as the hidden areas of middle ear, can be easily identified in an HRCT. Information regarding the status of ossicular chain erosion, erosion of lateral semicircular canal and fallopian canal can also be well appreciated by this scan. The

delineation of pathology prior to surgical exploration allows the operating surgeon to plan the most appropriate surgical approach that is required. The information about the possible anatomic variations helps in preparing for the difficulties that might not have been contemplated otherwise. Pre-surgical knowledge about status of ossicular chain also allows the surgeon to be ready for ossicular chain reconstruction and to advise the patent regarding degree of hearing attainable after surgery.

CONCLUSION

The results of this study suggest that preoperative HRCT imaging in cases of cholesteatoma, ossicular chain erosion, and SCC dehiscence have good correlation with intra-operative findings.

However, HRCT is not able to distinguish between cholesteatoma and mucosal disease, facial nerve dehiscence, incus and stapes erosions in the early stages. HRCT can act as a guide to the nature of disease, potential dangers and possible complications, and this information can assist the surgeon in the choice of surgery to be performed and better advise the patient on the degree of hearing attainable after surgery.

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PROFORMA

Name : Age/ Sex IP No.

Address: DOE:

Occupation:

Complaints:

H/o Present illness

Details of complaints

Mode of onset

Time of onset

Duration

Course

Unilateral / bilateral

Aggravating / Relieving factors

H/o ear discharge – (foul smelling +/-, blood stained +/-)

H/o hard of hearing

H/o ear pain

H/o blocking sensation in ear

H/o ringing sensation in ear

H/o headache

H/o trauma to ear

H/o previous ear surgery

H/o Recurrent upper respiratory tract infection/sneezing / allergy /

Irritation and watering of eyes

H/o fever

H/o Nasal discharge/post nasal drip

PAST HISTORY

H/o similar complaints before

H/o previous surgery

H/o Noise trauma

H/o previous trauma

H/o Bleeding diathesis

H/o Drug allergy

Treatment History

Duration of treatment

Medical / Surgical

Medical Topical Oral

Improvement if any

Personal History

Diabetes / Hypertension / Pulmonary TB / Seizure / Bronchial asthma

Sinusitis / Allergic rhinitis

Smoking / Alcoholic

Psychiatric disturbance

Family History

H/o similar complaints in family

General Examinations:

Patients Conscious,

Oriented,

Febrile,

Anaemia +/-

Icterus +/-,

Generalized lymphadenopathy +/-,

Generalized edema +/-,

Clubbing +/- ,

Cyanosis+/-

RS - NVBS, no added sounds

CVS – S1 S2, no murmur

P/A – soft, no organomegaly

CNS – NFND

LOCAL EXAMINATION OF EAR

EAR	RIGHT	LEFT
PINNA		
PREAURICULAR REGION		
POSTAURICULAR REGION		
EXTERNAL ACOUSTIC MEATUS		
TYMPANIC MEMBRANE PERFORATION SIZE SITE MARGIN		

TUNING FORK TEST RINNE WEBER ABC		
TRAGAL SIGN		
MASTOID TENDERNESS		
FACIAL NERVE FUNCTION		
NYSTAGMUS		

NOSE	RIGHT	LEFT
EXTERNAL NOSE		
NASAL VESTIBULE		
NASAL CAVITY		
NASAL SEPTUM		
NASAL MUCOSA		
INFERIOR TURBINATE		
MIDDLE TURBINATE		

EXAMINATION OF ORAL CAVITY:

EXAMINATION OF THROAT:

EXAMINATION OF NECK:

PROVISIONAL DIAGNOSIS:

PREOPERATIVE EVALUATION:

1. OTOENDOSCOPIC EXAMINATION
2. PURE TONE AUDIOGRAM - HEARING LOSS WITH AIR BONE GAP MEASUREMENT (COHL / SNHL)
3. HRCT TEMPORAL BONE
4. DNE to rule out RHINOSINUSITIS
5. ROUTINE INVESTIGATION FOR ASSESSMENT FOR SURGERY

DIAGNOSTIC NASAL ENDOSCOPY PROFORMA

Govt. Rajaji Hospital, Madurai
Department of ENT

Name: Age / Sex :
IP/OPNo. Date :
Indications :
Headache :
Nasal block :
Nasal discharge :
Epistaxis :
Anosmia :
Sneezing :
Scope(s) used : 0° / 30° / 45°

I – Pass Nasal mucosa Inferior turbinate Inferior Meatus ET – orifice Nasopharynx Fossa of Rossenmuller		
II – Pass Nasal mucosa Superior Turbinate / Meatus Supreme Turbinate / Meatus Spheno ethmoidal Recess Sphenoid ostia		
III – Pass Nasal Mucosa Middle Turbinate Middle Meatus Uncinate Bulla Hiatus Accessory Ostia		
Nasal septum & Mucosa		

Conclusion :

Advice :

ABBREVIATIONS

TM	-	Tympanic Membrane
PTA	-	Pure Tone Audiogram
CP	-	Central Perforation
dB	-	Decibels
COHL	-	Conductive Hearing Loss
SNHL	-	Sensory Neural Hearing Loss
HRCT	-	High resolution Computed Tomography
ABG	-	Air-Bone Gap

URKUND

Urkund Analysis Result

Analysed Document:	FINAL THESIS.docx (D42425187)
Submitted:	10/11/2018 2:39:00 PM
Submitted By:	lhamdorjee2k9@gmail.com
Significance:	11 %

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